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TASMANIA

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN
No. 1

HE MANGANA GOLDFIELD

BY

W. H. TWELVETREES
Government Geologist

Issued under the authority of the Hon. D. C. Urquhart, Minister for Mines

Hobart:
John Vail, Government Printer

1907

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CONTENTS.

PAGE
I.—INTRODUCTION 5
II.—PREVIOUS LITERATURE 5
III.—PHYSIOGRAPHY 6
IV.—GEOLOGY 7
V.—ECONOMIC GEOLOGY 10
VI.—HISTORY 11
VII.—MINING 14
(*a*) Mangana Gold Reefs Mine 14
(*b*) Golden Entrance Mine 25
(*c*) Alpine, Buckland, and Cardinal Mines 28
(*d*) Tower Hill Mine 31
(*e*) Fingal Company's Mine 32
(*f*) Union Jack Mine 32
(*g*) Pincher Reef 33
(*h*) Specimen Hill 33
(*i*) Alluvial at Mangana generally 35
(j) Conclusion 36

PLATES.

1. Geological Sketch Plan ... ... } At back.
2. Mangana Gold Reefs ... ... } At back.
3. Section Mangana Gold Reefs ... ... } At back.
4. Golden Entrance Mine ... ... } At back.
5. Photograph of Mangana Gold Reefs Shaft ... ... Page 16
6. Photograph of Mangana Gold Reefs Battery ... ... „ 17

THE MANGANA GOLDFIELD.

[Four Plans, Two Photos.]

I.—INTRODUCTION.

MANGANA is a small township, 5 miles from Fingal by road, situated on an alluvial flat which forms the floor of a valley bounded by hill spurs descending from Ben Lomond and Tower Hill. The hills rise steeply from the plain, and consequently give the place a picturesque aspect. The native name Mangana had some connection with the river, for *Mangana Lienta* signified the South Esk River, distant 4 miles to the south.* A back road over the hills runs north to the township of Mathinna, and a tourist track has recently been made to the shelter-hut near the summit of Ben Lomond, where Col. Legge has established a thermometer station. The grade of the track up that mountain is comparatively easy, and Mangana forms an excellent base for expeditions. Mountaineers cannot do better than place themselves in the hands of Mr. Donald McLeod, of the Alpine Hotel, Mangana, who will make all arrangements for the ascent.

The goldfield is situate in the area of slate and sandstone strata of Lower Silurian (Ordovician) age, which forms a large auriferous belt of country running through to the northern coast of the island, and embracing the goldmining districts of Scamander, Mathinna, Mt. Victoria, Warrentinna, and Lyndhurst. The exact prolongation of the strike of the Mangana strata would cut the River Tyne near its confluence with the South Esk, and not the Mathinna field, as frequently asserted. The line of the Mathinna strata extended south-east emerges on S. R. J. N. Talbot's 500 acres, in the bend of the South Esk River, near Fingal.

II.—PREVIOUS LITERATURE.

The following reports have been published by the Government of Tasmania:—

1. Gold at Mangana, by Chas. Gould, Government Geologist, 31st July, 1869 (Legislative Council Paper No. 20).

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* Fenton's "History of Tasmania," 1884, p. 443. The word "Munnna," however, denoted wattle-tree gum; and "Mungunna" was the word for fish.

2. On some portions of the Mangana Goldfield, by Alex. Montgomery, M.A., Government Geologist, 25th September, 1894 (Report of the Secretary for Mines, 1894-5).
3. On the strata in the shaft of the New Sovereign Mine, Mangana, by W. H. Twelvetrees, Government Geologist, 6th November, 1899.

Mr. Gould describes four reefs discovered by Mr. J. C. Goodall along the summit and flanks of the ridge dividing the tributaries of Major's Gully, which are charted as Golden and Fern Tree Gullies. He is of opinion that if the shafts which were then being sunk prove the reefs to hold as good in depth as they appeared to be on the surface, there is sufficient stone in sight for several years' crushing.

Mr. Montgomery reports on the Reunion, Cardinal, Buckland, and Alpine mines; and on Specimen Hill workings.

The report on the New Sovereign Mine is an examination of the shaft workings of the mine now owned by the Mangana (Tasmania) Gold Reefs Company, Limited, as far down as 280 feet, the then depth of the shaft.

III.—PHYSIOGRAPHY.

Mangana was originally called the Nook, and the little valley forms a veritable nook at the base of the high hill ranges which rise abruptly from its borders. These hills are lofty spurs, which divide mountain-stream channels or ravines known as Richardson's Creek, Calder's Gully, Major's Gully (resulting from the confluence of Fern Tree and Golden Gullies), Grant's Creek, Sharkey's Gully, Sailor's Gully, &c. The spurs rise immediately round Mangana to a height of 700 or 800 feet, and towards the north they continue rising, and constitute shoulders or buttresses of Tower Hill, the summit of which is nearly 6 miles northwest of the township, and 3900 feet above sea-level. About 1000 feet above and north of Mangana is a small farming settlement called the Towers. Richardson's Creek receives the waters of the various creeks mentioned above, and itself flows into the Tower Rivulet (locally known as Ben Lomond Creek), a tributary of the South Esk River, 3 miles west of Fingal. The latter river follows a tortuous course of nearly 100 miles, till it empties into the Tamar, at Launceston. In the lower part of Major's Gully the Creek flows under the surface of the shingle. The narrowness of these gullies and the steepness of their sides point to the excavating work of the streamlets having been performed in comparatively recent times. When they cross the course of reefs, they do good service to the prospectors by exposing these, and enabling them to be worked by adit levels. In the northern part of the field the direction of the ravines is more or less north and south, coinciding approximately with the strike of the reef-lines, and these consequently contribute to the formation of spurs which resist denudation. Hence the most accessible parts of reefs are frequently at high elevations.

IV.—GEOLOGY.

The strata of the field consist of slate and sandstone, considered to belong to the Ordovician (Lower Silurian) system. No fossils have been found confirming this reference, which is made only on stratigraphical and analogical grounds. The alternations of sandstone and slate show the cleavage partings in the rock to be mostly coincident with the lines of bedding. The sandstone is generally crystalline, and the whole series has been subjected to the processes of compression and cleavage, which in Tasmania are believed to have operated strongly at the close of the Silurian. It is made up of finely-divided detritus, derived from the wearing down of quartz felspar (granite) rock masses, which have now entirely disappeared from the locality, if indeed they ever existed in this part of the island.

The general strike of the beds is N. 25° W., and east of the township their general dip (underlay) is to the north-east, while west of Mangana, on the hills above Calder's and Major's Gullies, and on the Black Boy spur in the township itself, the strata dip to the south-west.

An anticlinal arch appears to have existed over the present flat of the Fingal (Grant's Rivulet) valley in the north angle of the township, and the reef-lines throughout the district are probably related to the processes of compression and strain, which may be considered responsible for the formation of this arch.

A strong unconformity exists between the slates and the beds of grit, conglomerate, and mudstone, which overlay them, and which pertain to the Permo-Carboniferous system. On the hills north of the township, at a height of between 950 and 1000 feet above the level of the plain, a layer of this conglomerate, 30 or 40 feet thick, covers the Ordovician strata. The pebbles are quartz, and sometimes slate, embedded in a sandstone matrix. Small cliffs of this conglomerate are exposed on the hill ridge between Calder's and Fern Tree Gullies, about 5 chains south of W. Gellibrand's 157 acres, at 1000 feet above Mangana. On the Alpine Hill, also between Richardson's Creek and Calder's Gully, stones of this conglomerate are strewn on the surface about 100 yards north of the Alpine outcrop workings. Boulders of reddish sand and grit enclose pebbles of sandstone, slate, and quartz. A little further south, between the Alpine hut and the Cardinal shafts, a few feet of Permo-Carboniferous sandstone appear to overlie the older slate. East of Mangana, at the head of Sharkey's Gully, near Talbot's gate on the divide, and at an elevation of between 600 and 700 feet above Mangana, the hill capping is composed of Permo-Carboniferous mudstone. The residue of this covering is nowhere thick, and it is easy to see that the slate throughout the district has nowhere suffered any great denudation since it was first buried below the Permo-Carboniferous sediments. From this fact it may be inferred that no great waste of gold quartz reefs can have taken place, and, consequently, that the amount of gold present in the alluvial does not afford a fair criterion of the value of the reefs. Fossiliferous mudstones occur high up the shoulder of Tower Hill, as well as on the Fingal township. The difference of level between the two exposures points to considerable faulting somewhere, but it would require a very close examination of the geology of the locality to locate the line of displacement. The plain through which the South Esk River flows consists partly of alluvial matter, which was deposited in Tertiary times, and this gravel has been shown by borings to go down below the level of the present river bed. This alluvial becomes shallower towards Mangana, and at the township it is not more than 30 or 40 feet in depth. It gradually gives place to the modern wash of the mountain creeks in ascending the gullies. In Tertiary times the deposit probably extended higher up the low hill on Robertson's Freehold, to the west of the township, but some denudation must have taken place during subsequent elevation of the land. These Tertiary deposits in the South Esk basin extended as far north from Fingal as the present site of Mathinna.

Igneous rocks appear at a few places on the Mangana field, but, genetically, are quite unrelated to the gold quartz reefs. The summit of Tower Hill is formed of diabase (greenstone or trap), the plagioclase-augite rock which everywhere is found intrusive in the coal measure sedimentaries (both upper and lower, *i.e.*, Permo-Carboniferous and Mesozoic) as sheets, pipes, dykes, or in some other form. On the flanks of the hill below the summit is a fringe of Permo-Carboniferous strata, but whether these pass underneath the diabase or whether the latter cuts them off is as yet an open question.

On the track to the Alpine Mine, about 400 feet up the hill, is a small patch of diabase, which has come up through the slate at this spot. The igneous rock is here greatly decomposed, and does not appear to be exposed for a width of more than 20 feet.

A further exposure of the same rock is on the 20-acre block of Robertson's Freehold, west of Mangana. It occupies the western part of that block and the southern angle of the adjoining 31 acres, and extends westward to the mining sections, ¼-mile distant, forming a considerable mass.

A similar rock forms the top of Ben Lomond, the Fingal Tier ("Bare Rock"), and other heights in the neighbourhood. Microscopical examination shows an absence of the type of structure which would denote a deep-seated (plutonic) rock, as well as of that which characterises effusive (volcanic) rocks. Their micro-architecture (diabase type) conforms with that of rock masses which exist as laccolites or intrusive sheets.

The age of these rocks is not older than late Mesozoic, as it is clear that they have intruded into our Upper Mesozoic shales and sandstone, but any closer determination than this seems impossible for the present.

The quartz reefs at Mangana are for the most part enclosed in the Ordovician slate and sandstone strata. Only at one point did I see what appears to be an upward extension of the reefs into the overlying Permo-Carboniferous, viz., on the Buckland Spur, where an exposure in a trench shows a somewhat feeble continuation of the quartz into the flat-lying younger sandstone. However, more extended examination is necessary before what would appear to involve a younger age for such a reef can be used decisively for building any theory upon it. Quartz veins have been observed in the coal-measure sandstone elsewhere (on Ben Lomond and near Buckland, as well as at Port Cygnet). But the Mangana reefs typically are confined to the older strata, and their occurrence is probably closely connected with the tectonic processes of folding, which may be conceived as having released and enclosed the siliceous residue of the granite magma. That reef-formation is in some way related to the bending of the beds may be inferred from the change in dip of reefs when found east or west of the township. All the reefs east of the Fingal Valley axis have an easterly dip, while those on the Buckland or Alpine Spur dip to the west. It is highly possible that a reef or reefs may exist along the axial line of folding below the plain of the Fingal Valley.

V.—ECONOMIC GEOLOGY.

The gold-bearing quartz assumes the form of veins and reefs, for the most part running in northerly and northwesterly directions, generally conforming with the enclosing strata in strike and dip, and varying in width from mere threads to as much as 25 feet in width. Some of these reefs are barren, or at all events not payable. The quartz generally is white and glassy, and not as a rule charged very heavily with pyrites. Where pyrites is present, the dominant species is iron pyrites. Arsenopyrite is subordinate. Copper pyrites, galena, and blende occur sporadically, and are good indicators of the proximity of gold. The rich stone found near the surface in this district has probably been indebted to processes of solution and re-precipitation for its wonderful gold contents (Golden Entrance quartz having yielded 39½ ozs. per ton). Some of the reef-channels have been the seat of subsequent movements, which have torn and forced apart both quartz and the slate laminæ, widening the reef and giving it a mottled appearance, which, if accompanied by pyrites, is a favourable augury for gold contents. Oxidised parallel partings in the stone are welcomed by the miner as very apt to carry gold. The reefs in the hills to the east of the township are in directions which cause them to cross the gullies, and the latter, notably Sharkey's and Sailor's, must have removed considerable quantities of quartz while carving out their channels. On the other hand, on Major's and the Alpine Hills, the ravines mainly run parallel with the reefs, which consequently have only been subject to the denudation going on upon the hill spurs.

It is probable that much of the alluvial gold which has come into Mangana from the north was not shed from the Alpine and Major Hill reefs, for these reefs are not cut by the main ravines. The local opinion is that the Permo-Carboniferous conglomerate or cement is responsible for a good deal of it.

Gold has been found both in the cementing sand of this conglomerate and in quartz contained therein, and the iron oxide with which much of the alluvial gold coming from the northern part of the field is coated confirms the idea that gold is derived from the ferruginous cement. This is the view held locally, and much can be adduced in its support. There is not the slightest reason why alluvial and specimen gold should not exist in the Permo-Carboniferous conglomerate. During the time that it was being laid down the gold-bearing reefs were exposed, and must have shed their waste much as it is being shed to-day. It must be remembered, however, that these conglomerates were probably extensive sea beaches, and concentrations of gold in them were likely to be few and far between. Still, some auriferous runs may be found in them, and prospecting in this formation may be encouraged.

VI.—History.

The first discovery of payable gold in Tasmania was made at Mangana, in February, 1852, about 150 yards below the present bridge. The Launceston *Examiner*, of 18th February, 1852, stated:—

"Letters have been received in town announcing the discovery of gold within 4 miles of Fingal, by James Grant, Esq., of Tullochgorum. The following is an extract from a letter from a gentleman in the neighbourhood, dated the 16th instant:—'Gold has been found within 4 miles of Fingal. I saw it myself. The largest piece was the size of a duck shot, the other pieces smaller.'"

Another paragraph appeared in the Launceston *Examiner*, of the 12th May, 1852:—

"James Grant, Esq., of Tullochgorum, has claimed on behalf of Keeling Richardson the reward of £500 offered by the Launceston committee in September last for the discovery of a goldfield in the northern side of the island. He states in the memorandum which he has submitted to the committee that, of the quantity forwarded, 1 oz. 38 grs. were procured by Keeling Richardson from about five bushels of soil, with the assistance of one man at the cradle, in eight hours.

"One of the pieces procured (a nugget) weighed 139 grs. The remainder consisted of smaller pieces."

Mr. James Fenton, in his "History of Tasmania" (Hobart, 1884), writes on the subject as follows:—

"The first payable gold in Van Diemen's Land was found at the Nook, 4 miles from Fingal, in February, 1852. It attracted about 200 persons for a short time. They thoroughly prospected the country round, and those who steadily persevered made it pay. Very minute particles of gold-dust were procured along the Tower Hill Creek and on the hillsides, where beautiful specimens of crystallised quartz abounded, but in a few weeks the place was left in the hands of a few of the original claimants, who made a fair profit on their industry for a considerable time."

Mr. J. C. Goodall, the pioneer who has done so much in the way of prospecting and mining at Mangana for the last 42 years, has furnished me with the following statement, which gives some interesting historical information. He says:—

"I visited Mangana in 1866, and found the Union Company's quartz mine at work, this being the first gold-bearing reef discovered in the colony. The developments were being carried on by adits, and a 10-head battery was crushing the stone. On Grant's Creek the Fingal Company was shaft-sinking and quartz-crushing with a 10-head battery. The yield varied from 5 dwts. to nearly 1 oz. per ton, obtained by both companies. The Union was by far the more promising of the two mines. Its reef was from 4 to 12 feet wide, with some bulges of stone up to 20 feet, but the widest parts were poor, averaging from 3 to 7 dwts. per ton of fairly rough gold. An open-cut was put in half-way up the hill on a discovery of rich stone with very rough gold, so rich that I saw the manager crush over 50 lbs. weight in the mortar and it yielded over 4 ozs. gold. Several stones crushed by hand gave 1 dwt. of gold to the pound. In working this discovery barren reef matter and mullock were crushed with the richer stone, and the battery average was brought down to less than 10 dwts. per ton. Some time after this the Union Company closed down, and remained idle for years.

"The Fingal Company's mine was on a short shoot of stone worked to 170 feet in depth, and, on the whole, was not payable. The mine is situate on private property, and has been idle the last 30 years. I paid special attention to the country at the head of Fern Tree and Golden Gullies to ascertain whence the alluvial gold of Major's Gully was derived. On 10th January, 1869, I discovered the Tower Hill reef, showing good payable gold quartz, but to my astonishment I found it was on privately-owned land, 157 acres, belonging to the late William Gellibrand. Eventually a company was formed in Hobart, and I put up a 10-head battery. We had several crushings of good 2-oz. stone, but two or three poor crushings frightened the shareholders and directors, and the mine was closed down. Only surface-scratching was afterwards done by co-operative parties, until the machinery was destroyed by fire. In 1877 I discovered the Alpine reef on Crown land, and secured the lease of Buckland's Freehold, on which estate I also discovered the Buckland No. 1 reef, which produced over 1000 ozs. of gold from 1319 tons quartz. The reef was from 18 inches wide at surface to 3 feet wide at the bottom of the winze, 170 feet. The Alpine and Buckland estates were floated into three separate companies in Hobart. The Alpine reef was not proved to any great depth (about 150 feet), and some excellent crushings were obtained. A few poor crushings caused work to be abandoned. Later I took up the forfeited Union leases, and discovered the Sovereign reef, on the top of the hill, which I worked for about a year, and then sold to a London company (Mangana Gold Reefs, Limited). I have prospected lately on the Buckland's Freehold, a 30 years' lease being held by Launceston investors, who also intend to start work on the Buckland No. 1 reef by putting in an adit 100 feet below the old workings. The last crushing from the bottom of the winze was 80 tons, yielding 152 ozs. gold, some 21 years ago."

Mr. James Fenton writes:—*

"The first quartz-crushing company (the Fingal) commenced operations in April, 1859. Its machinery was imperfect. It obtained about 250 ozs. of gold during the first four months. The stone crushed yielded 8 or 10 dwts."

Looking at Mangana as it is at present, with its numerous reefs exposed and mines idle and giving employment to not more than half a dozen men, it is difficult to realise that this was the first goldfield in the Colony. Although Mr. Fenton gives the priority to the Fingal Company,† I am informed that the Midland Company was the first quartz-mining company, which afterwards successively became the Union, the Reunion, the Sovereign, the New Sovereign, the Mangana (Gold) Reefs, Limited, all working on the reef in the Union or Sovereign Hill. Some of the richest quartz known in Tasmania came from this reef. All the gullies were scoured for gold in the old times, and responded excellently to the search. Major's

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* "History of Tasmania," Hobart, 1884, p. 308.

† He probably means the company at the Fingal diggings, as the Mangana field was then called. This company was then known as the Midland.

Gully has the reputation of having been the best, and gave employment to 400 men in its palmy days. The largest nugget found on the field was obtained from Fern Tree Gully, which feeds Major's. It is variously reported as 7 ozs. and 11 ozs. in weight. Sharkey's Gully, opposite the hotel, also used to yield rich specimen quartz. The Golden Entrance Mine, on the divide between Sharkey's and Sailor's Gullies, has yielded about £10,000 of gold-bearing quartz, but it is now struggling along on tribute.

It is difficult to avoid recognising that in the old days a mistake was made in selling the mineral land round the township The consequence is that many reefs are now on private property, and the mining population of Mangana, instead of prospecting and developing the lodes in the surrounding hills, leave their homes during the week and occupy themselves with tin-mining on Ben Lomond.

VII.—MINING.

(*a*) *Mangana Gold Reefs Mine.*

Mangana (Tas.) Gold Reefs, Limited.—Sections 1259-93G, 30 acres; Section 557-G, 10 acres; and 318-93G, 5 acres, battery site.

A gold quartz reef of variable width, but attaining in places a maximum width of 25 feet, runs right through the hill on Section 1259 from Sailor's Gully to Sharkey's Gully, and various outcrops have been also found on the southern section (557), one of which must be the southern continuation of the reef. It seems to be almost certain that the reef is traceable at surface for at least half a mile, and this is a strong indication of its persistence to a depth greater than that of the present workings.

The average bearing of the reef is N. 42° W., and the dip to the north-east. There is very little difference between the strike of the enclosing slate and of the reef itself; sometimes the bearing of both is identical; in dip, also, the reef follows the country.

Apart from the light decolourised slate in the superficial zone, the workings show mostly dark slate down to 200 feet below the gully, purple slate from 200 to 600 feet, and a compact grey slate between 600 and 800 feet. Where the reef is wide the quartz is mixed considerably with slate, giving the stone a mottled aspect. The width varies from under a foot to as much as 25 feet, of which, in the upper parts of the mine, from 4 to 6 feet of solid quartz is met with, the remainder being mixed quartz and slate, occurring irregularly in the reef-channel. The slicken-sided lode slate points to reef movements subsequent to the deposition of the original vein quartz.

The reef minerals are pyrite, arsenopyrite, and a little galena and copper pyrites. The reef belongs to Beck's group of pyritic gold quartz reefs, in which the dominant sulphide is iron pyrites.

The former companies which worked this property (Union, Reunion, Sovereign) operated on the reef in the hill on the north side of Sailor's Gully, while the present company has explored it from a main shaft sunk to 800 feet below the gully floor. I am informed by Mr. J. C. Goodall that the first gold found in quartz at Mangana was obtained from this reef (Union). There is no return available of the total gold won, but it is certain that the amount was by no means inconsiderable, and some rich shoots were met with in the upper workings by the early companies.

Upper Adits in Hill.—As said above, the work done prior to the present company consisted of adits driven north-west into the hill on the course of the reef. These are at different levels from Sailor's Gully to within 60 feet of the apex of the Sovereign Hill, the highest one communicating with the summit by means of the Sovereign shaft. Altogether, these upper works comprise 2200 feet of driving, 300 feet of crosscutting, and 750 feet of sinking and rising, besides an unascertainable amount of stoping.

The main adit (No. 4) has been driven into the hill from near the new shaft at 25 feet below the collar of the latter, and has been extended north-west 550 feet. No. 3, 112 feet above No. 4, has been driven 720 feet; No. 2, 94 feet above No. 3, has been driven 625 feet; and No. 1, 137 feet above No. 2, has been driven 275 feet.

All these have been driven on the reef, which in places is from 10 to 20 feet wide. Its character is extremely irregular, often soft and mullocky, and again widening into large bodies of hard stone. The quartz is white and but little mineralised, and very largely dissected by bands of slate.

No. 4 Adit.—At a little distance in this adit the reef-channel is 5 to 6 feet wide, but soft and mullocky, developing into a mixture of quartz and slate, the quartz often showing in curved bands. A little north of the main shaft the reef has been stoped up to surface and down to No. 1 level in the new mine. It is reported to have carried very good gold at times.

At 190 feet in a crosscut has been driven out south-west for 100 feet without intersecting anything of importance. It passes through regularly laminated slate country, dipping north-east. At one point a small vein of valueless quartz was cut. The crosscut was of distinct use as establishing the non-existence of parallel reefs outside the main channel. Between this and the 180-feet air-shaft (Union shaft) the reef has been stoped to surface on 2 feet of quartz for 120 feet beyond the crosscut in the Union shaft, but beyond this there is not much quartz in this level. The face is 240 feet beyond the shaft, and this part of the adit is in soft, dark lode slate, which has been mostly worked with the pick. Short crosscuts would have to be put out each way behind the end to prove the width of the reef. The face carries lumpy white quartz for a width of 5 feet 8 inches. This stone, although barren, has a more favourable look than anywhere in this level north of the Union shaft. Further 400 feet of driving would bring this level under the Sovereign shaft, and in doing this it would pass below the large block of ground stoped

MANGANA REEFS SHAFT.

between the level above and the surface, and also meet the gold shoots pitching south.

East of the entrance to this adit a wide spur of quartz has run off to the east. Its full width has not been actually proved, but about 20 feet of it have been taken out and crushed. The stone for a width of 3 feet is reported to have returned 1 oz. gold per ton. What is left is valued at about 5 dwts. The hard bands of clean stone are said to carry the gold, which realised £4 per oz., the highest value on the property, as the general range of the rest is from £3 10s. to £3 14s. per oz. The stone at the top of the hill was exceedingly rich, and it is said that the bulk of the gold was obtained from there.

MANGANA REEFS BATTERY.

No. 3 *Adit*.—This has been driven 720 feet. At the entrance the reef has an unusual westerly underlay. It is soft and small (2 feet 4 inches wide), and runs in soft arenaceous slate. As far as the Union shaft, the channel is mullocky and uninviting, but after passing the shaft the reef becomes harder. Its hanging-wall is smooth, and footwall ragged. The level has followed a somewhat serpentine course. At about 250 feet north of the shaft the reef has been stoped up to No. 2. Just before this hard big stone comes in, and is exposed in the drive for a width of 9 feet. Some extraordinarily rich stone is reported to have been obtained from above this level—as much as 30 ozs. per ton. The shoot of golden stone appears to have been shorter in this level than in the one above it. I could not reach the end of the drive owing to it being blocked by a fall.

No. 2 *Adit.*—This has been driven 625 feet. Inside the entrance the reef is 7 feet wide, and there appears to be still more stone to the east. Quartz carrying gold 1 oz. per ton was obtained from here. Going north the reef attains a width of 12 feet. At about 100 feet from the Sovereign shaft the level is blocked by a fall of ground. The lode is said to have been lost in the end. The reef-channel has a westerly underlay in this adit.

No. 1 *Adit.*—This is the uppermost level, and has been driven 275 feet. The reef here consists of a channel of stone and mullock 20 feet wide. Near the entrance it is composed entirely of mullock. The quartz bodies here evidently make in bunches or blows. The Sovereign shaft, communicating with the apex of the hill, is 200 feet in, and there is a fine body of low-grade quartz here, estimated as worth a little under 4 dwts. gold per ton. From the large excavation seen, the stone has been worked up and down and in the side spurs. The reef becomes smaller after it passes the crown of the hill. In the end of the adit it is 3 feet wide, of which 18 inches are stone and the rest is mixed mullock and quartz. The sample taken from this adit by the manager and sent to London assayed 7 dwts. per ton.

Driving this adit 90 or 100 feet further would bring it out to daylight on the northern slope of the hill overlooking Sharkey's Gully, and No. 2 adit, if continued further 280 or 300 feet, would also emerge on the side of the hill, and even if driven only 150 feet it would come into country where it would have only 60 feet and less of backs.

These upper workings are evidently patchy, and the gold shoots seem short; but it seems to me worth while to relocate them and test the ground around and below them, so as to find some patches that would pay for working and relieve costs while development is going on at a greater depth. No. 4 adit might well be extended further into the hill, and would have a fair chance of intersecting some of the principal shoots.

Workings from Main Shaft.

No. 1 *Level,* 115 *feet.*—The crosscut driven 29 feet south-west from shaft is in mottled stone and slate all the way. The drive north-west, 87 feet in length, is on the hanging-wall of the reef. Good stone has been driven on, and stone is still left inside the western wall of the drive. Solid stone is showing in the end. The reef has been worked from this level up to the No. 4, or main, adit, and down to the next level, 60 feet below, for a length of between 60 and 70 feet.

No. 2 *Level,* 174 *feet.*—This level has been driven north-west from the main shaft for a distance of 175 feet on the course of the reef. The reef is exposed in the chamber west of the shaft, showing about 5 feet of mottled quartz, nearly vertical. The stone has been taken out above this level for a length of about 100 feet. Fifty feet from the shaft is a short crosscut which intersects the reef, here 19 feet of mottled stone, dipping 50 degrees to the north-east. For 3 feet in this crosscut the quartz is very solid. Ninety feet beyond the crosscut solid stone 50 inches wide has been left standing, and the softer reef matter worked on each side of it. The west branch has been followed 10 or 12 feet, while the main drive has followed the eastern parting. Further north the stone enters the drive again, and the solid part of the reef widens out in the end to 19 feet. There seems to be plenty of quartz, and the problem is to find shoots of gold sufficient to pay for working. If this drive were continued it would meet the gold shoots from the hill workings.

No. 3 *Level,* 214 *feet.*—There is a wide band of reef matter here in the shaft, but the width has not been proved west. The formation is quartz and lode-slate. The level has been driven north-west at 12 feet west of the shaft, and continues on the reef for nearly 200 feet, but the end is partly blocked by a recent fall, owing to heavy rains. The reef as followed is 2½ feet wide, consisting of mottled quartz and dark slate, with a good hanging-wall of black, greasy slate, dipping north-east. The slate forming the walls throughout the level is soft and mullocky. Old stopes exist above this level.

No. 4 *Level,* 319 *feet.*—A crosscut has been driven from the shaft north-east for 50 feet, and levels driven north-west and south-east on the reef, the former for 150 feet and the latter for 125 feet.

Drive North.—The reef in this drive hugs the footwall side. The level begins on seams of quartz, and the formation is mullocky, which does not look very inviting, but the manager reports that it is worth 7 dwts. A cuddy east goes through slate seamed with flat veins of quartz, and fair stone (worth 7 or 8 dwts., I am informed) goes down in the sole of the level just opposite this. A little further north a rise has been put up to No. 3 level. Tributors worked here and did very well while the gold lasted, on a reef about 2 feet wide. Stone as high as 13 dwts. was got, but going up it grew poorer. Continuing in this level, some of the roof has been brought down by water, as the reef-channel is soft all the way. However, a change takes place in the end of the drive, and the first solid quartz in this level is met with. The face is solid white quartz, dipping north-east, at from 60 to 65 degrees. This stone is nicely mineralised. The manager informs me that it is worth about 3 dwts., but as there is fair gold at different points in the level the drive ought to be continued.

Drive South.—The reef is followed on the footwall side of drive, showing quartz veins 5 inches to 1 foot wide. The stone is said to be of good quality for this mine, and the manager recommends a rise being put up just south of the intersection of crosscut. The end of the level shows only dark slate with a few narrow veins of quartz. The drive here is apparently off the reef, and a short crosscut has been put in easterly 25 feet behind the end, but has only intersected a 7-inch flat vein of quartz. Some more cross-cutting is required to clear up matters.

No. 5 *Level,* 419 *feet.*—A crosscut north-easterly has been driven 137 feet from the shaft chamber. At 150 feet it intersected the reef. Throughout the crosscut the slate country is much disturbed and intersected by quartz veins, which are often greatly puckered. For the greater part of it the veins dip west; afterwards this underlay changes to east. Some of the veins are quite horizontal.

The reef has been driven on north-westerly for 90 feet on a mullocky channel. It must have been rather difficult to choose the place for driving, as the crosscut is crowded with quartz veins; but the right selection has evidently been made. About 40 feet from the beginning of the level a few tons of stone were taken out over the roof, returning, I am told, about 3 ozs. gold per ton. This stone showed no visible gold, but was mineralised with pyrite, copper pyrites, and galena. The channel here is 10 feet wide, but without walls. Veins of quartz appear in the roof and wall of the drive, and at half a chain from the end a small crosscut has been opened, showing a band of quartz dipping east. The end of the level is in silicified, barren country, intersected by seams of quartz, and consisting mostly of siliceous lode slate. Though no gold has been found at this point, gold-bearing stone is quite likely to be met with if the drive is continued, as in the level above a nice shoot, though very short, was left going down at about this distance from the shaft. This level seems to have been stopped on account of poverty of the reef, and because no funds were available for prospecting.

The level 200 feet below leaves too great a distance between the two levels. Either No. 6 might have been driven, or a winze sunk from this drive.

No. 7 Level, 619 *feet.*—At this level crosscuts have been driven north-easterly and south-westerly, and from the eastern one a level has been driven 170 feet on a small reef.

The eastern crosscut has been driven 260 feet, nearly to the boundary of the section. At its commencement a few stray bands of quartz from the formation which descends with the shaft are seen. At 38 feet from the shaft a 3-inch vein of quartz runs across the crosscut, and 10 feet further along is more stone in the form of irregular veins, and still further is quartz in patches. The country is twisted round in curves, and the dip consequently is variable, sometimes vertical, or even west, but reverts to its normal easterly direction.

A couple of small stopes above the roof of the level have yielded 5 tons of stone; the yield is reported to have been 7 or 8 dwts. The quartz is apparently in bunches, as clean country is left in the roof; but it was never wide in this level, the stone being from 8 inches to a foot. Fifteen feet behind the end of the level a winze has been started in stone 4 to 6 inches wide. The end of the drive shows lumpy quartz 3 or 4 inches wide in the upper part of the face, dwindling as it goes down to a mere track of black slate. If this is the reef driven on in No. 5, as it in fact seems to be, its underlay has become much steeper between the two levels, increasing in fact from 55 degrees to 75 degrees inclination from the horizontal.

The west crosscut has been driven 110 feet south-westerly from the main shaft. Veins of quartz connected with the shaft formation occur immediately on the western side of the shaft. Three feet behind the face of the crosscut a formation of quartz and slate about 4 feet wide was passed through. The quartz veins, 2 and 3 inches wide, twist with the folds of the country, and the stone is white and barren. This reef is not so strong in the roof, where it is represented by a few 2-inch veins of quartz, but in the lower half of the drive it is fairly strong on both sides. The stone is not very attractive looking, but should not be passed by without a short drive being put in. The end of crosscut is in light-coloured slate, dry, and regularly laminated.

No. 8 *Level*, 719 *feet*.—A chamber has been cut here and a drive put in for 40 feet in a north-westerly direction. Stone is scattered all over the roof of the drive, but the channel proper seems to be 3 feet wide, and is filled with mixed quartz and slate. The country-rock dips in its usual direction of north-east, while the quartz veins underlie south-westerly. The quartz is vitreous looking. The shaft here carries a reef-channel 7 or 8 feet wide, which tails out in hard slate in the western chamber.

No. 9 *Level*, 819 *feet*.—The bottom crosscuts have been driven at this level.

East Crosscut.—This has been driven 140 feet north-easterly from the shaft. At 12 feet from the shaft a block of slate with veins and patches of quartz occurs in the upper part of the crosscut. The quartz has come down from the shaft, but nothing is visible in the floor of the crosscut, so this seems to be the bottom of it. In this drive there is a barren cross-course with a little quartz on its hanging-wall crossing in a north-easterly direction, about 2½ feet wide, and dipping north-westerly. The filling is dark slate. A little water is issuing from it, but the occurrence does not seem to be of any importance. In the end of the crosscut water is dripping, and a lode-channel of some sort is coming in with a north-easterly dip. The proper position for the main reef, judging from its position in No. 7 level, is about 40 feet ahead of this point.

West Crosscut.—This has been driven 113 feet south-westerly from the shaft. In the shaft itself stone has been passed through all the way from the chamber above, and is seen in the western chamber in the form of torn bands of quartz up to 6 inches in width. At 46 feet from the shaft a slide crosses the drive, striking N. 20° W., and dipping south-westerly. Half-way between this and the shaft is a 3-inch vein of quartz visible in the roof, and 6 feet west of the fault is a patch of quartz, also in the roof.

It does not live to the south-eastern side of the drive, but its track in that side is indicated by somewhat softer slate. Just west of it some water trickles from the roof. When money is available, it might be driven on to make sure that nothing is neglected. Dish prospects have not shown any gold. In fact, no colours have been got from any trials at this level. The end of the crosscut is in grey slate, vertical, and very regularly laminated.

At 100 feet west of the shaft a drive is proceeding south-east on a reef-channel about 14 inches wide, and carrying in the end 5 or 6 inches of quartz. The footwall is smooth and well defined. The reef is nearly vertical, dipping at about 80 degrees to the north-east. Its filling is quartz and black lode slate. No mineral is discernible without washing. If the present angle of dip is maintained, this reef would enter the main shaft at about 280 feet lower down.

A small battery of 15 heads is situated at the mouth of Sailor's Gully, and is connected with the mine by tramway. The stamps are 7 cwts., and driven by a 14-horse power engine with Cornish boiler 28 feet by 6 feet 6 inches.

There is a Berdan pan with belt attached, and a sawmill connected with the plant for cutting all wood used in the mine; also an assay-house and furnaces, and a cyanide plant for treating the battery sand.

If the mine becomes payable, it will be by treating large quantities of stone, and for this the battery would have to be enlarged.

Everything at this mine is in good order, and the work carried out in a workmanlike and efficient manner. All that is necessary now is to settle the programme for future operations, and work with a definite object in view.

Reviewing the work done on this reef in former and recent years, it is undeniable that the deeper sinking has proved disappointing. The reason of this appears to be that the shaft has been sunk deep enough to pass out of the upper zone of gold-bearing stone, and not yet sufficiently deep to enter the second zone. The upper zone, as far as it has been proved, seems to occur in the reef from the surface down to about 200 feet, more or less. No stone has been taken out in quantity from lower than 300 feet.

Considering the developments in the upper part of the reef as being all connected with one another, and constituting a gold-bearing reef-shoot pitching at a rather low angle (30 to 40 degrees) to the south-west, there is a probability that this will continue south-westerly into the adjoining section, which hitherto has only received desultory attention in the way of prospecting. Quartz has been cut in trenching at different points on this section on the slope of the hill falling towards Sailor's Gully, and I think this slope merits systematic exploration. Apart from the 300-feet level, no driving south has taken place from the main shaft, and it would be strange if the gold-bearing stone on the north of the shaft were not found on the south side as well. Exploring in this direction would necessarily mean following the stone successively to deeper levels. In addition to this work, it is worth considering whether the upper levels from No. 4 upwards, as well as the main adit, should not be continued north, so as to test the reef thoroughly below the hill workings. While this exploration work is in progress, prospecting might be undertaken in the upper adits, with a view of breaking stone that would at least pay crushing costs and relieve general expenses during search and development work down below. The whole proposition seems to be a low-grade one, and while considerable quantities of stone exist of a quality nearly payable, there is the chance that patches of sufficient extent may be found to raise the whole to an average that would pay for raising.

An alternative is to continue sinking the main shaft until another gold-bearing zone is met with; and such a zone, on the theory of parallel shoots, will probably in time be encountered, but at what depth it is impossible to say.

Underlay Reef.—This is on the company's property on the south side of Sharkey's Gully, bearing N. 5° W., and dipping easterly at about 30 degrees. It is thus a rather flat reef. At 5 chains south-east of the north-western corner of Section 1259 some very nice-looking quartz is exposed, laminated and impregnated with pyrites. This reef was worked between 30 and 40 years ago, and a trial crushing is reported to have yielded 6 dwts. It has been cut into for two or three chains, and seems to be fed by spurs of stone. One of these spurs is about 15 inches wide, a lode in itself. The reef is exposed to a width of 18 or 20 inches, but cannot be well examined, as the entrance to the underlay winze is blocked by a fall of stone. The workings now are evidently in a state that would discourage some from doing anything with the proposition, but the reef, *per se*, is somewhat attractive. It crosses Sharkey's Gully and passes north right through the old Union Jack section to the Fingal Mine in Grant's Gully, where it was worked rather extensively. Reports of values vary from 6 to 10 dwts. On the south side of Sharkey's Ravine the reef strikes across a hill spur which would only allow of short and shallow drives on the reef-course unless a sufficient depth were secured by a shaft.

(*b*) *Golden Entrance Mine.*

Sections 1547-93G, 1569-93G, and 1568-93G—10 acres each.

This mine has been working intermittently since 1900, and is now being exploited on tribute by Messrs. Madden and Macleod. The reef was discovered by Mr. J. S. Goodall, Jun., since when 1050 tons of stone have been crushed for 2801 ounces of gold, of the value of £10,264 9s. 11d., averaging 2 ozs. 13 dwts. 8 grs. per ton. The first crushing yielded 39½ ozs. gold per ton.

The reef crosses Sailor's Gully. About 20 feet above the track on the north side of the gully a small cutting was made into the reef nine or 10 years ago by Mr. Goodall, and a little gold said to be obtained. A body of slate and quartz has been exposed for about 10 feet, and some blocks of solid quartz thrown out.

Lower Tunnel (No. 2).—This is aout 150 feet above the gully. Angle of slope of hill, 30 degrees. The adit has been driven on the reef for 150 feet in a north-west direction. The reef dips east here, while there is a local underlay of the country to west. At 20 feet in is a shallow winze 7 feet, sunk on material carrying a little gold. The reef-channel is filled for the most part with soft decayed slate, with a rather regular veinlet of quartz and a few bunches of quartz in the formation. Six-inch veins of quartz cross in the roof and east wall. Those in the roof are rather solid, but on their strike they die out and are replaced by slate. Twenty-five feet behind the end the country-rock is a more massive and siliceous grey slate in the lower part of the drive. In the upper part a cross-course comes in, striking west and dipping north 55 degrees. The level has been driven through to the north wall of the cross-course, and has touched the siliceous wall-rock, which is freely impregnated with pyrites. Driving has stopped here, but it is not clear that the reef has been heaved. If a displacement has taken place the reef, according to the laws of faulting, should be sought to the west. The workings ahead show that there cannot have been much dislocation, and the best way would be to drive on and put in short crosscuts.

Winze Adit (No. 1).—This is 180 feet above the lower adit, and has been driven 270 feet on the reef on a course varying from N. 40 degrees to 46 degrees W. The reef dips north-easterly, and the country south-westerly. At the entrance a winze has been sunk to 100 feet on the hanging-wall, with a very steep dip. A little way in the adit is an air-pass to the level below. The stone stoped was from a few inches to 7 feet in the widest part. At 140 feet in the No. 2 shaft from surface passes through this adit. Half a chain beyond the shaft a fall of ground has blocked the level, but it has been driven 2 chains further north. The timber in roof prevented examination, but the stone above here was very rich—6 to 7 ounces gold per ton. This was not continuous, but in patches. Only a little stone is now seen in the level, clinging to the east wall. The channel is filled with black greasy slate and pug.

Twenty-five feet below the level is an intermediate drive, which has been driven both ways. The south drive is for about 40 feet, and carried good stone. I was informed that 81 tons were taken out for 289 ozs. The reef varies here from a few inches to 2½ feet at the widest. The south drive has been mostly stoped up to the level above, except just near the shaft and towards the south end.

No. 2 Level.—This is 45 feet below the collar of the main winze, and connects No. 2 shaft and winze. Towards the south end near the winze a small sink was made 6 feet below the floor of the level, and 50 tons of stone taken out and crushed for about 350 ozs. of gold. This was the last parcel mined and sent over to the Bairnsdale School of Mines for treatment. Just south of No. 2 shaft a pass goes down 24 feet to an adit driven from the north side of the hill.

The stopes above this level were in stone up to a foot in width. The sink referred to above shows quartz going down on the east side of the drive for a couple of inches wide only, but exceedingly rich stone was obtained from this point.

No. 3 Level.—This has been driven from the bottom of the main winze (No. 3 shaft) for 10 feet south and 50 feet north. The chain ladder had been taken away from the bottom, so these lower workings could not be examined. About 30 feet below No. 2 the track of the stone passes through the shaft corresponding with the southerly pitch of the make of quartz, but all along the No. 2 level there is very little stone.

Surface.—North of No. 2 shaft the outcrop of the reef twists in a serpentine way to the west, and resumes its normal bearing when it reaches No. 1 shaft. This change (accompanied by a flattening of the underlay) is also seen in the stopes above No. 1 level, but not in the level itself.

No. 1 *Shaft.*—This is 250 feet north of No. 2 shaft, and has been sunk to 108 feet. It is the point where work was first done on this mine. When 30 feet deep 480 ozs. of gold were won from 24 feet by 30 feet of reef, and one parcel of 4½ tons is stated to have yielded 25 ozs. per ton. A few tons of gold-bearing quartz are lying outside the shaft, but were not considered rich enough to send away. There is a fair amount of pyrite in the stone, and the gold occurs in rusty patches, which represent decomposed pyrites. This probably accounts for the unusual richness of the quartz in free gold.

At 50 feet a level has been driven 30 feet south and 50 feet north. The ground has been stoped south for 15 feet from over the back of the level to surface, and north for 30 feet to 20 feet high. At 80 feet down, drives have been put in for 17 feet south and 30 feet north, and 20 feet north of shaft a winze connects the two levels.

No. 4 *Shaft.*—This is 31 feet north of No. 1 shaft, and has been sunk on the reef to a depth of 30 feet by the present workers. A few tons of stone have been raised, but not enough to send away yet. It is situate on the south brow of the hill, about 1566 feet above sea-level.

Sharkey's Gully Adit.—This has been driven on Section 1568 from the north side of the hill first as a crosscut in slate for 420 feet, and then on the course of the reef as far as 30 feet south of No. 2 shaft, and 24 feet below No. 2 level, with which it is connected by a pass. At first the reef-channel is about 2 feet 6 inches in width, filled with quartz and soft country. Near the end a little gold was met with, where there were a few inches of quartz and a soft "dig," about 18 inches altogether. The stone is mineralised.

A characteristic of the Entrance reef is a little parting, which forms a track that can be easily used as a means of identifying the reef. The stone occurs on each side of the soft parting.

General Remarks.—There is abundant scope for useful exploratory work at this mine. The bottom level on the south side of the hill should be extended so as to bring it below the upper workings, and shafts Nos. 2 and 3 deepened to connect with it. The ground below No. 3 level and south of No. 3 shaft may be expected to carry the continuation of the shoot which was stoped above, but below a certain distance from the surface the lode enrichment will possibly be found not to continue. The reef in depth will then have its normal characteristics. If necessary, a lower tunnel can be put in from Sailor's Gully below No. 2, at a spot where there is a fine body of stone at surface, and fairly mineralised.

(c) *Alpine, Buckland, and Cardinal Mines.*

The mountain spur between Richardson's Creek and Calder's Gully comprises parts of two 320-acre blocks owned by C. and H. J. Buckland. Some important reefs have been worked on this spur, and several others have been discovered and trenched upon at surface.

Alpine Reefs.—These are about 1000 feet above Mangana, on the western of two sections once held by the Alpine Company, north of and adjoining the Buckland Gold Mining Company's section. The reefs were discovered by Mr. J. C. Goodall in 1877. About the centre of the section they appear to unite, and form a single reef, which continues north beyond the limits of the section, and disappears under a capping of Permo-Carboniferous conglomerate. The two reefs going south vary in width, but attain a maximum of 2 or 2½ feet. They seem, however, to be only a few feet apart, and perhaps may be better considered as one reef formation. An adit has been driven at 100 feet lower than the outcrop, and the reef stoped upwards. The Alpine Company erected a 10-head battery at the mouth of Calder's Gully, constructed an incline and tramway, and got between £2000 and £3000 of gold. Stone from the winze sunk to 100 feet below the adit is stated to have returned gold at the rate of 18 dwts. per ton. A low adit was started down in Calder's Gully, which it was calculated would give 600 feet of backs. This was driven over 400 feet, and from the face a horizontal diamond-drill bore was put in for further 545' feet, making 945 feet altogether, without reaching the reef. Mineralised rock was shown in several of the cores. According to the survey the eastern reef should be 600 or 700 feet ahead of the bore.

Buckland Reefs.—The Buckland No. 1 reef was also discovered in 1877 by Mr. J. C. Goodall, and an adit driven which intersected it at 160 feet. A winze was sunk 110 feet on it, and levels opened out on it north into the Alpine ground at 45 feet and at 70 feet. These were connected by a winze, and an underlay winze was also sunk from the 70-feet level a further depth of 50 feet. At the 45-feet a level was also driven north. A good deal of stone was broken, which has been reported as having yielded from 12 dwts. to over 1 oz. gold per ton. Mr. J. C. Goodall informs me that 1319 tons quartz were broken, returning 1001 ozs. 13 dwts. gold, during the time that he was mine and battery manager—September 7, 1883, to September 16, 1884. The last 80 tons crushed during Mr. Peter Irvine's managership were from the lower levels, and gave 38 dwts. per ton.

At the tunnel level, 110 feet from surface, the length of payable stone, according to plan, was 85 feet, and beyond that, in a southerly direction, the drive was extended 150 feet, but met with no payable stone. The quartz stoped below this level seems to be pitching north, and at 30 feet down the mine plan shows a new shoot of gold as having come in, and continuing downwards in stone 5 feet wide. These workings are inaccessible now, so there are only reports to go upon, but these are from former managers who were well acquainted with the mine. Mr. Peter Irvine, who is still a respected inhabitant of Mangana, says the average width of stone was 3 feet, and its average quality all through equal to 18 dwts. per ton.

The low Alpine tunnel was unfortunately abandoned before success was achieved. At present too little is known of the reef to warrant such a long adit at such a depth, but eventually, if work at more moderate depths proves satisfactory, it may become advisable to extend it. For the present a more desirable course would be to prove the reef by an adit a more reasonable depth below the present workings.

Cardinal Reef.—This is on the western brow of the spur, and near its southern end. Its bearing is N. 28° W., and its dip south-west. Three shafts have been sunk along the line of reef. The principal one, I understand, is 100 feet deep, but none of them can be entered in their present condition. Complete figures relating to the former output are not available, but accounts point to 167 tons being raised from the 50-feet level stopes, returning 13 dwts. gold per ton. Some of the stone is said to have gone as high as 35 dwts. The reef in the bottom was not payable. Mr. Goodall, who has come to my assistance with many valuable statistics of this field, tells me that the reef in the south end was 4 inches to 12 inches wide, and in the north end about 2 feet, but poor. Mr. Macleod states that tributors crushed 20 tons of stone left at the shaft for 8 or 9 dwts. per ton, and some odd parcels gave from 15 dwts to 1½ oz. The Cardinal is in a reefing line which embraces some parallel reefs, one of which at least is of considerable size. Mr. Goodall has done a good deal of trenching in this zone, north of the Cardinal shafts, and has exposed a strong reef of solid quartz in half a dozen trenches and an open-cut at intervals for over 4 chains from south to north on the N. 20° W. course of the reef. The first trench is about ¼-mile north of the Cardinal shaft, and west of the Cardinal reef. A hundred feet north of this trench is the open-cut, which has been carried down 16 feet, showing solid stone 8 feet in width. Apparently this reef is widening as it runs north, for it was not more than 4 feet at the most southerly trench. The most northerly trench (which I did not see) is reported as exposing 17 feet of quartz. The open-cut has given gold prospects, and prospects obtained from surface loam lower down on the slope indicate a possible source in this reef-belt, which is about 100 feet in width. The reef in question has been called No. 1 reef, on the Buckland Freehold, which leads to confusion with the old Buckland No. 1 Company, which worked a different reef altogether. As it is such a prominent reef, and is a permanent land-mark on this ridge, it might be called Goodall's No. 1 reef, for sake of distinction.

Adit prospecting suggests itself for any one undertaking mining here, as adits could easily be laid out to go right below the outcrop at any depth desired. As for the Cardinal reef, it thins as it comes north, and is apparently replaced by Goodall's No. 1.

It will be noted that both country and reefs on this hill dip to the south-west, being on the western half of the Fingal Valley anticline. The quartz of which the various outcrops consist is the massive white variety which so often characterises the surface exposures of the reefs of the Mangana field, and in some districts might be looked upon as unfavourable. Experience at Mangana, however, has shown that high yields of gold have been associated with vitreous-looking quartz, which is often intersected by oxidised partings, forming a favourite matrix for gold, and which in depth frequently changes its character altogether, and becomes a mottled, laminated stone, with a fair proportion of mineral. Whether any particular "buck" reef will behave in this way is another question, but at any rate the vitreous habit of the quartz is, *per se*, not sufficient reason for condemning the reefs.

(*d*) *Tower Hill Mine.*

This is an abandoned mine on W. Gellibrand's purchased land, 157 acres, 3 miles north-north-west from Mangana, and over 1000 feet above the township. Like so many of the Mangana reefs, this one was discovered by Mr. J. C. Goodall, in 1869. It was worked by a Hobart company, and Mr. Goodall tells me that at first several crushings of good stone were taken out (up to 2 ozs. per ton), but after some poor battery-runs work was suspended, and has not been resumed since, except by co-operative parties. No very clear idea of the reef can be formed from the workings in their present condition. It has a north-westerly bearing, and shows at surface about 4 feet of white mineralised stone, disappearing to the north. The mine is on the spur between Golden and Fern Tree Gullies, with adits driven from the eastern side.

About 5 chains south of Gellibrand's boundary are some cliffs of Permo-Carboniferous conglomerate and soft quartzose sandstone, with embedded pebbles of white quartz and slate; and nearer the mine sandstone, belonging to the same system occurs also, though the reef itself is in the older slate. The slate dips south-west. The reef has a north-east dip.

Descending hence down Fisher's Hill, towards Mangana, on the west side there is a good deal of loose quartz, heavily charged with arsenical pyrites. The hill consists largely of grey sandstone, freely veined with quartz.

I did not see the Golden Gully Mine, which is a little way up that gully on the east side. I am informed that some fairly nice stone occurred on surface. An adit was driven with 50 feet of backs, but though there was a good body of mineralised stone it was barren of gold.

On the west side of Major's Hill outcrops of quartz have been tested a little. Some of these have a kindly look; others are hard and white. On the ridge, which is a razor-back, are stones of quartz of fairly loose texture.

These hills north of Mangana do not appear to have had the work done on them which their reefs would require. Some of the alluvial gold found in the gullies must have been derived from them, and their lines are too long and persistent for gold not to exist in them at some point in their course.

The reef-line on Robertson's Freehold, further south, seems to correspond with the Major's Hill line, and the Buckland Hill line with the sections on Otway's Creek.

(*e*) *Fingal Company's Mine.*

This was worked at least 40 years ago, on Grant's Creek. The greatest depth attained was 170 feet, and the mine does not seem to have been a payable one. The workings are 2 chains from W. Robertson's boundary, on Tully and Downing's land, and are on two parallel reefs a chain apart. Most of the gold was got out of the western reef, which is supposed to be that of the Golden Entrance. A good deal of hard white quartz is lying about at surface. The eastern reef was worked about 100 feet down on the underlay, and corresponds approximately in position with the line of the Union Jack and underlay reef further south. The battery which was formerly here is supposed to have recovered 6 or 7 dwts. from the stone. Mr. Cundy worked out some blocks of stone here 10 years ago, and got 6 dwts. per ton.

This is the furthest north that these long reefs have been seen. It is a remarkable instance of the persistency of the reefs at Mangana. In this instance the Golden Entrance reef would be shown to have a length of 1¼ mile, and the underlay reef ¾ mile.

(*f*) *Union Jack Mine.*

This reef is the continuation of the underlay reef, which passes up the hill north of Sharkey's Gully into Section 1527-93G, which is the old Union Jack claim. A little north of the south-west angle of the section is an ancient adit, which has been driven on the course of the reef for 250 feet. The latter still has a flat underlay to the east. In the adit about 8 inches of stone are showing at first, but further in it becomes softer and somewhat broken. At 200 feet in an underlay rise slopes up to a shaft which was sunk from surface. The inclination of the reef is sufficiently flat to walk or scramble up the rise. The shaft is 70 or 80 feet above the adit. Above the latter is an upper tunnel, driven right through the crown of the hill, with only 30 feet of backs at the most. The entrance to this is now fallen in. From the bottom of the shaft a small parcel of 1-oz. stone was taken. The quartz used to be trammed from the upper tunnel along a horizontal tramway for 150 feet west, and sent down an incline to Sharkey's Gully for treatment in the old Union Quartz Company's battery. The reef is so flat that it crops out at surface at 100 feet west of the tunnel and 12 or 15 feet above tunnel level. It cuts the country, being much flatter than the parting planes of the slate. The appearance of the stone corresponds well with that of the underlay reef in Sharkey's Gully.

Five or 6 chains east a large reef crops out, with an easterly underlay. It is 12 feet wide, and has the characteristic central parting of the Golden Entrance reef, which, in all probability, it is. It is strongly mineralised with pyrite and iron oxide. The eastern portion of it is the more solid. Its bearing is about N. 40° W. It has been trenched upon in one or two places, the most northerly being 80 feet south of the southern corner of Section 1589. This should be driven on lower down the hill, and a rise would then cut the underlay reef as well.

What is probably the same reef has been cut further north, on W. Robertson's eastern block, where a shaft has been sunk on it. It shows there solid quartz about 1 foot in width. A few feet further north a cut has been put in, but not deep enough to expose any quartz. About 200 feet lower down, going north on the same course, is a small pit, about 12 feet deep, of which 6 feet consist of hill debris or overburden. Doubtless the same reef continues to the old Fingal workings.

It is impossible to form an opinion of these reefs from the abandoned ancient workings, but if any work was justified then, there would seem to be warranty for further testing them.

(*g*) *Pincher Reef.*

This reef is on the hill east of the township, where it overlooks the entrance to the Fingal Valley, or Grant's Creek Valley. Some tunnelling and shaft-sinking have been done on it, but how much stone has been taken out cannot be seen, neither are results available. It has a strike of N. 50° E., and dips south-east at an angle of 70°, and shows a width of 2 feet 4 inches stone between walls. The country is hard sandstone.

(*h*) *Specimen Hill.*

This is a low, somewhat flat-topped hill, on Robertson's Freehold Blocks, west of the township, covered with wash on the lower slopes. A little surfacing has been done with encouraging results, but there is not enough pressure of water available. The crumbly quartz detritus lying on the surface has apparently been shed from a series of veins running through the hill in a north-north-west direction, and forming an auriferous belt of about a chain in width. The slate strata crop out on the top of the hill, striking N. 20° W., and dipping south-west. On the southern block of the freehold property stones of Permo-Carboniferous grit and mudstone are scattered over the ground, and it is probable that there is an occurrence of beds belonging to that system *in sitû* somewhere near here. This would indicate that the undiscovered fault which has brought these beds down from the upper level to the Fingal township horizon must pass north of this. On the two northern freehold blocks diabase comes in, and passes away to the west as an intrusion, cutting-off the slates. Its former Permo-Carboniferous covering has been entirely removed by denudation.

Some shafts have been sunk at intervals on the line of quartz leaders and veins. The most southerly is the Trilby shaft, which is 50 feet deep. Some very nice gold was got here on Crown land, a chain inside the east boundary of 829-93G, 10 acres. A quartz gold-bearing wash rests on a yellow clay, which covers the slate bed-rock. North of this several trenches have been cut and quartz veins exposed. The depth of the wash varies from 8 inches to a foot.

Further north, in the freehold land, is Goodall's shaft, near the top of the hill, which has been sunk on a mass of quartz leaders. Quartz detritus lies here everywhere on the surface. The shaft was sunk 40 or 50 feet 12 or 14 years ago. Just below it a strong body of hard valueless quartz has been exposed.

Brennan's tunnel is an adit which has been driven into the hill on the western side for about 200 feet, at a shallow level, not more than 30 feet below the crown of the hill. It was put in with the intention of cutting the reef, but only one or two veins were intersected. This was about nine years ago. I do not think the position selected was a favourable one for the best results, as if the adit were continued, it would eventually emerge on the east side of the hill above the leaders there. A few stones of white barren quartz are seen on the tip.

Some trenching has been done in the depression running down the east side of the hill, and passing through a belt of small veins, some of which are oxidised and have a kindly aspect; others, however, being hard and white. A tunnel was put in on this side some years ago, and a flat vein near it carried very fair gold. There is an old shaft just above the tunnel with quartz going down in the walls. Near this point is the head of the gully workings.

On Specimen Hill proper a shaft was sunk eight or nine years ago by Mr. Corbett to a depth of 130 feet in slate, dipping south-west. One or two gold-bearing leaders were passed through in sinking. From the bottom a crosscut was driven east. I was informed that nothing was won from this, but some nice specimens were got from trenching near the shaft. A few tons of quartz and slate were sent away for crushing, and returned about 5 dwts. per ton.

In the earlier days many of the auriferous leaders on this hill were pounded up and washed. Just north of this point diggers started on the alluvial gold shed from this hill, and kept working round the foot and up the gullies, in which a considerable quantity of gold seems to have been concentrated. There has been so much gold obtained in this way from the surface that it is next to certain that more exists at a depth. Whether the numerous veins unite in depth and form a strong reef-channel can only be ascertained by actual work, but it is, to say the least, probable that they do. The hill being so low in elevation (50 to 100 feet) adit-driving cannot be thought of. Mr. Montgomery advised sinking rows of shallow shafts and connecting them by drives. This would be useful preliminary work, but the real work of testing the reef or reefs would best be carried out from a shaft sunk to some depth, and well below the broken ground, which may be expected to prevail above the level of the Mangana Valley. A water scheme has also to be devised.

(*i*) *Alluvial at Mangana Generally.*

The actual lead or ancient bed of the tributary which flowed formerly from Mangana into the valley now occupied by the South Esk, a good deal below the present bottom of that river, cannot be traced with confidence above Mangana township. The ground at the mouths of the present mountain creeks does not exceed 40 feet in depth, and has no doubt accumulated from the creeks which flow down narrow ravines of comparatively recent origin. All these valleys have given employment to diggers, who have at different times worked some of the ground over and over again. The alluvial ground below Mangana deepens towards the South Esk, and, probably owing to it being private property, has never been thoroughly tested. It must have received a certain amount of gold from creeks which have now disappeared with the erosion of the country, though owing to the direction of the lead coinciding with that of the strata, and being parallel with the bearing of the principal reefs, the quantity of gold finding its way into the drift is likely to be less than if the main valley crossed the strata. If the land had been open for mining its value, no doubt, would have been tested ere now.

It is difficult to ascertain how much alluvial gold has been won at Mangana. An estimate made in 1884 placed it at £60,000 worth, and assigned 6000 to 8000 ozs. to Major's Gully alone. Later estimates state 5000 ozs. as the gross returns. No figures pretending to any degree of accuracy can be obtained.

Major's Gully is said to have supported 400 diggers at one time. Near its mouth the ground is deep and wet, water flowing beneath the shingle, which chokes and hides the channel from view.

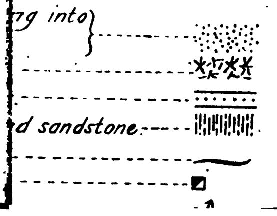
(*j*) *Conclusion.*

The present condition of Mangana, considered as the earliest goldfield in the island, is somewhat pathetic. It has been left by investors on one side, while the stream of capital has flowed to other centres. And yet the phenomenal returns from some of the reefs should suggest that there is here a legitimate field for search. The reefs, too, are in the golden zone, which extends for such a distance in this part of Tasmania. Some of them are barren, others are gold-bearing, and the chances appear to be neither more nor less than those of other parts of this auriferous belt. The Mangana Reefs is the only property on which anything like deep work has been done; the workings on other reefs are shallow, and often mere scratchings. Mangana evidently has not had a thorough trial yet.

W. H. TWELVETREES,
Government Geologist.

Launceston, 22nd November, 1907.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.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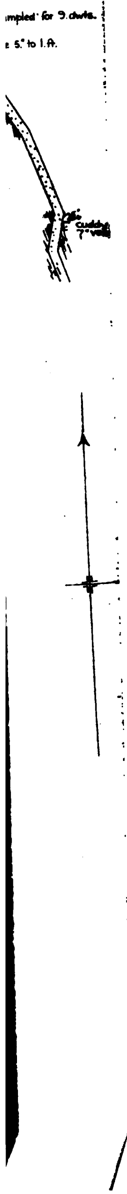
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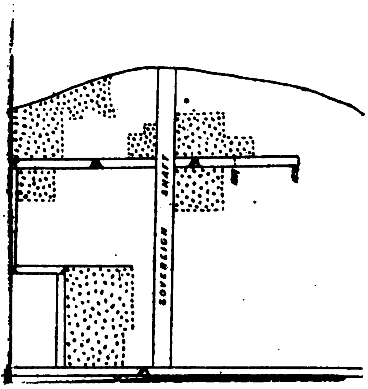
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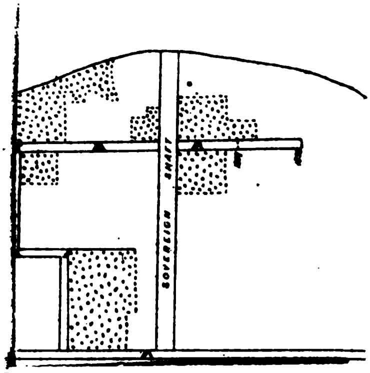
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Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN
No. 2

HE MATHINNA GOLDFIELD

PART III

BY

W. H. TWELVETREES
Government Geologist

Issued under the authority of the Hon. [illegible] Urquhart, Minister for Mines

Hobart:
JOHN VAIL, GOVERNMENT PRINTER

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CONTENTS.

PAGE

I.—INTRODUCTION 5
II.—PHYSIOGRAPHY 5
III.—GEOLOGY 6
IV.—ECONOMIC GEOLOGY 7
V.—MINING 7
- (*a*) Scott and Pickett Reef 8
- (*b*) Commercial Reef 11
- (*c*) Pride of the Hills Reef 11
- (*d*) O'Brien's Reef 12

PLATES.

1. Locality Plan of Reefs ... ... } At back
2. Plan of Levels of Scott and Pickett Gold Mine ... } At back

THE MATHINNA GOLDFIELD.

PART III.

[Two Plates.]

I.—INTRODUCTION.

THIS part of the Mathinna Report deals with a comparatively small and outlying portion of the field, situate round the Scott and Pickett Mine in the upper part of a narrow valley which joins further north with that of the Sling Pot Creek, forming then one broad flat between the Volunteer and the Volunteer Consolidated spurs.

The slate and sandstone strata in which the Scott and Pickett valley has been carved out belong to the Ordovician auriferous series prevailing at Mathinna and Mangana. In respect of position in this series, they occupy a line of country apparently between the Golden Gate and Consols line on the north-east, and the Mangana line of country on the south-west. This line would embrace the strata on the mineral sections north of the Tower Hill farms.

II.—PHYSIOGRAPHY.

About ¼ mile north of Densley's land, the Sling Pot or Bull Bottom valley contracts, and the Sling Pot Creek forks off in a slightly west of south direction, leaving the Bull Bottom or Scott and Pickett valley heading a little south of east. The latter valley is now not more than 500 feet wide, but up at the mine narrows to a mere "V" shaped ravine. The valley and the hillsides are clothed with fine timber, comprising stringy-bark, iron-bark, peppermint, swamp, or white-gum, some of the trees from 10 to 20 feet in girth. A few small farming selections have been taken up along the valley, but the soil is none too fertile, and there is a deplorable dearth of water. After the spring snow-waters have descended from the mountain the creek subsides into its normal trickle from pool to pool, percolating through the sandy soil, and of little use either for farming or mining. The elevation of these farms is about 1100 feet above sea-level.

Above the Scott and Pickett battery the sides of the valley draw closer to one another; the slopes are steeper.

The sky-line on the tableland above is visible at a height of 500 and 600 feet. This is the high plateau connecting Mathinna with Tower Hill, which is between 3 and 4 miles south-west. The drainage of this part of the country is northwards into the South Esk River.

III.—GEOLOGY.

The strata of this part of the field are similar to those of the Mathinna field proper, and are of the same geological age. Alternations of soft, glossy clay slate, decolourised in the superficial zone, with sandstone and sandy slate occur everywhere. The sandstone is generally tough and crystalline, and constitutes locally the "hard" country of the miner.

The general direction of the cleavage planes of the slate and the laminations of the sandstone is from N. 20° to 30° W., and the dip or underlay to the south-west. A singular variation of dip is seen in the battery building of the Scott and Pickett Company, where the slate dips to the north-east at an angle of 45°. I have not seen this dip anywhere else on the strike of these strata, and the normal westerly underlay prevails to the immediate east, and also to the west, across the valley. It must, therefore, be a purely local disturbance.

The dominant dip of the strata to the north-west in this area, continuing also north-east to the Gladstone and Eldorado Hills, seems to show that the whole of this belt forms the west side of the anticlinal arch of the New Golden Gate and Tasmanian Consols line, to which I have referred in my previous reports.

About 500 feet above the Scott and Pickett, or 1700 feet above sea-level, stones of grit and conglomerate begin to appear on the hillside. These can be traced up to the plateau, where this formation covers the older slate. It belongs to the Permo-Carboniferous, and has been described in my recent report on the Mangana Goldfield. Its occurrence shows as plainly as anything could do, that the slate and sandstone strata of this field could not have suffered any very great loss by denudations before they were covered up and protected by the layer of conglomerate, which at one time must have spread in a wide belt all over this part of the country.

The nearest igneous rocks are the occurrences of diabase (of Mesozoic age) east of Fonthill and on Tower Hill, but they have no sort of connection with the auriferous quartz reefs at Mathinna.

IV.—ECONOMIC GEOLOGY.

Not many reefs have been opened upon in this part of the field, but the few which have been discovered belong to groups of the pyritic and arsenical gold quartz reefs. They are small, varying mostly between 15 and 21 inches in width, but, as a rule, are persistent, as far as their channels are concerned, for considerable distances, though the development of stone may be irregular. When shoots of gold occur, the value of the stone ranges from 1 dwt. per ton to, perhaps, a little under an ounce.

The associated minerals in the different reefs are pyrite, arsenopyrite, copper pyrite, galena, and zinc blende. Stone has been found with all these minerals, yet without free gold, nevertheless it is safe to say that they are reliable indicators of the presence of the precious metal in the reef. The quartz of these reefs varies in nature from a brittle, milk-white variety, which, though often barren, sometimes shows galena and free gold to a bluish-grey arseno-pyritic variety, forming one of the best-looking kinds of stone on the Mathinna field.

All the reefs which I have seen are fissure reefs, transgressing the strike of the country strata. One set has a strike about N. 20° E., while the direction of another is N. 75° W., crossing the first at nearly a right-angle.

V.—MINING.

The reefs which have been discovered are few in number, but I doubt not that others remain to be found, for the overburden in the form of hill debris is so constant that the bare rock is seldom seen on the slope of the hills, and the only chance of unearthing a reef is by closely observing the small ravines which score the hillsides. There has been no very extensive prospecting, which is hardly to be wondered at, for to prospect effectively here means the expenditure of considerable time and money in opening-out long and deep cuttings, almost at haphazard. The cuttings must be deep, so as to avoid passing over the caps of lodes, which do not always come right to surface.

The reefs dealt with in this Report are:—

(*a*) The Scott and Pickett reef.
(*b*) The Commercial reef.
(*c*) The Pride of the Hills reef.
(*d*) O'Brien's reef.

(*a*) *Scott and Pickett Gold Mining Company, No Liability.*

Sections 525-G, 10 acres; 526-G, 10 acres; and 534-G, 5 acres.

This property is situate nearly 2½ miles south-south-west of Mathinna as the crow flies, or about 3 miles by road. It is on the east bank of the valley, which debouches further north into the marshy flat known as Bull Bottom. The battery is about 200 feet above Mathinna. The small creek which feeds it with an intermittent and inadequate supply of water flows past it down the valley through the farm lands to the north. A road has been cut recently right up to the property, though, as it is a little rough near the mine, carters look askance at it.

Mr. Pickett, prospector, was the discoverer of the reef, and the company bears his name, and that of his companion, Mr. Scott. The reef is an arsenical gold quartz one with a strike of N. 27° E., and dipping, on the whole, steeply to the north-west. This dip prevails at surface and down to the bottom level where the reef becomes nearly vertical, or shows a tendency to dip slightly to the east. This bending of the reef is probably a purely local feature.

Adit No. 1, *South.*—South of the shaft an adit crosscut has been driven 57 feet to the reef, which has been followed in a drive south-west for 110 feet. The reef-channel is a fracture line in the slate and sandstone strata, which course north-west at a right-angle to the reef.

Four trenches have been cut across the line of reef higher up the hill, north of the end of this adit level, mostly without exposing anything else than yellow, soft clay slate. The highest trench shows hard laminated sandstone, seamed a little with quartz.

On the opposite side of the small gully are several openings on the line of reef going south. One of these is a shaft where the reef has been stoped to surface. Further south, quartz is shown in a trench which has been cut on its course for about 10 feet. Trenches still further south do not show the reef, being probably too shallow.

No. 2 *Adit Crosscut.*—This was driven into the stope on this side of the hill, and has now fallen in. It was put in by the prospectors before the claim was floated into a company.

Main Shaft.—To prove the reef at a depth a 12-foot by 4-foot shaft, at 80 feet above the battery, has been sunk 62 feet plus 2½ feet well, and a crosscut driven from the bottom for 82 feet in a south-easterly direction. The reef was cut through at that point, and levels driven on it north-east and south-west. The channel here is 2 feet wide, with a 4-inch vein of clean quartz, the remainder being scattered quartz, pug, and slate.

North Drive.—Going north, the quartz increases to a width of 14 inches, but after 20 feet the stone dies out, and its line is replaced by a track of pug. Further on, the present manager has picked up a little quartz, 6 inches wide. A little gold has been carried from here to the face, and for about a foot it was shown to be payable. Beyond this is stone 10 inches to 12 inches wide, but with only a trace of gold, which continues in the roof. The reef in the face is 32 inches wide, with 3 or 4-inch bands of quartz interlaminated with slate. A pug seam occurs on the west wall, and on the east side is a lot of twisted greasy slate, favourable for reef formation. The slate foliae have twisted round to a course of N. 55° E., dipping south-east.

This is the most favourable-looking end in the mine. It is 50 feet behind the entrance of No. 1 north adit level, and something may occur between this and that. The upper level, also, is too near the surface to give satisfactory results in the first 100 feet. The owners will no doubt continue driving this end.

South Drive.—At about 10 feet south of the cross-cut gold began to make in the stone, which is from 10 to 20 inches wide, and has been followed up to the surface. Occasional bulges of stone, 3 feet in width, occur. The quality of the stone is said to improve as it goes up, but its length is dimishing. The length of stoping-ground at the drive level was about 30 feet, and there is said to be good stone going down. Beyond the south end of the stopes the track of the reef is marked by a line of pug, with a little barren quartz here and there. The face in the end of drive has a little water issuing from it. It consists of sandstone seamed and intersected by quartz veinlets, and has a line of pug on the west wall. There has been some twisting of the country here, as the strike of the strata coincides with that of the reef.

Where the reef was cut in the adit it was puggy for a width of 8 inches, and slightly mineralised. Here it was not gold-bearing, and it gives place along the level to quartz 4 or 5 inches wide, but still without gold. At 20 feet from the flat sheet payable gold came in, and the reef has been stoped up to surface about 50 feet above the level. South of this shoot of stone there is only the puggy track of the reef visible, with a little quartz here and there. I am informed that a little gold can be got from prospects along the floor of the drive; but this part of the level is evidently south of the shoot of stone which has been worked. As this pitches north, of course, higher up it has existed further south. In the south end of the level is a little pug, otherwise the face is in country sandstone, with slate on the west wall. I am told that all the crushings prior to the time of the present manager came from this block of stone.

Adit Level No. 1, *North.*—One hundred and seventy feet north of the south adit the reef has been driven upon from surface in a north-easterly direction for 100 feet without disclosing anything of particular value. At about 25 feet in a short shoot of 3-inch to 4-inch stone occurs on the west wall of the drive, and further in is a 1-inch vein of quartz associated with a bit of pug. Just behind the face a cuddy has been driven west for 6 feet. In the end of the level the face shows an inch or two of pug, and the rest is slate. This adit being in the slate belt and not far from surface is in soft country all through.

The official figures furnished by the company give the crushings taken from the mine as 92 tons for 38 ozs. 4 dwts., but a little uncertainty exists in respect of the tonnage. Further 80 tons are now being crushed at the mine, and the yield is estimated as likely to be somewhere in the neighbourhood of 15 or 16 dwts. per ton. When this crushing is finished, all available stone will practically be worked out, and the company will have to consider its programme.

A short shoot of stone like that in this mine can only be followed down by a shaft, and a further sink would show whether the reef widens as it descends. With its present width and value it could hardly be worked profitably at a depth, but, of course, if it increased in width the outlook would be more hopeful. The present shaft has been sunk in rather hard country, but the bottom crosscut is in the slate country to the east, which underlies west, so that softer rock may be expected in further sinking. It may be said broadly that at Mathinna, where-ever gold is met with it is always worth while to follow it and take the chance of improvements occurring. It is very improbable that this is the only shoot of gold in the reef. As the gold pitches north, obviously a fresh shoot would be soonest met with by driving south, but at a greater depth. By sinking deeper, also, it may be found that the present shoot of gold-bearing stone lengthens.

The continuation of the bottom drive north would be of an exploratory character. At about 20 chains north-east of the shaft an intersection by the Commercial reef takes place, according to the observed bearing of the latter; and in driving there is always a chance of meeting with intersections by reefs now unknown.

The quartz of the Scott and Pickett reef is for the most part a bluish grey quartz, carrying a great deal of arsenopyrite, with a little iron pyrites, zinc blende, galena, and copper pyrites. Large specks of free gold are not uncommon, especially in the whiter variety of quartz.

The 10-head battery attached to the mine would have to be improved if regular work were carried on; and a scheme for conserving water would also have to be devised. The present arrangements for crushing, conveying stone from mine, and conserving water are all impossible.

(*b*) *The Commercial Reef.*

This is on Sections 1292-93G, 10 acres; and 1293-93G, 10 acres; lying N. 80° E. from the Scott and Pickett, and on the brow of the hill, 500 feet higher up. The little gully in which the shaft is situate forks in two branches higher up the hill, and the Commercial sections are on the spur between the branches, where there is a broad and flat stretch of country, with stones and boulders of Permo-Carboniferous conglomerate scattered at intervals over the slate strata. A small quartz reef strikes S. 75° E., with hardly any underlay. What dip there is is to the north. A shaft has been sunk, and a little stoping has been done from the bottom. A long trench has been cut from this shaft westwards, and the reef taken out at surface. More trenches occur further west. The country at the shaft is soft slate; at the west end of the trench, seriticised sandstone. As mentioned before, this reef and the Scott and Pickett will intersect, and it might be as well to try and locate the junction on surface. In addition to the shaft on the reef, another seems to have been sunk in the country near by. Some returns have been reported as 1 dwt. per ton; others, as 6 dwts.

(*c*) *The Pride of the Hills Reef.*

Sections 170-G, 10 acres.

This reef is about a mile from the Scott and Pickett, in a north-north-east direction, and between 400 and 500 feet above that mine. It strikes N. 17° E., and is vertical. Some 9 or 10 years ago a shaft was sunk 70 feet on the reef, and lower down the hill to the west an adit-level was driven on it for 51 feet. The reef in the face of the latter is 16 inches wide. The quartz is solid, white, and not well mineralised. Eighty or 90 tons of stone were broken out, and 15 tons crushed, for 15 dwts. of gold. The reef has been traced right over the hill. It would be interesting to trace the line of this reef towards the Scott and Pickett. The latter would lie as a parallel reef to the east of it.

A second reef exists near this one, and has also been sunk upon.

(*d*) *O'Brien's Reef.*

This is on Crown land, 9 chains south-west of the Scott and Pickett battery. It has been recently uncovered in the bank of the creek up the hill, opposite the battery. A small cut exposes it as a solid reef about 21 inches in width, lying between thinly foliated slate, but turning off south and cutting into the country as a flat reef. Its bearing is 15 degrees south of east, and dip southerly. The stone is hard and white, and unkindly in appearance. No gold has been recovered from it.

CONCLUSION.

The locality described in this Report is a little remote from Mathinna, but its reefs are in the same general auriferous belt. They are, in fact, at rather an extreme distance from the Mathinna axial line of folding, but it cannot positively be affirmed whether this fact operates prejudicially or not until the survey of the whole field is completed. Meantime there is no reason for ceasing to prospect, for the locality is demonstrated to have been within the range of the agencies which were concerned in the deposition of gold.

W. H. TWELVETREES,
Government Geologist.

Launceston, 13th December, 1907.

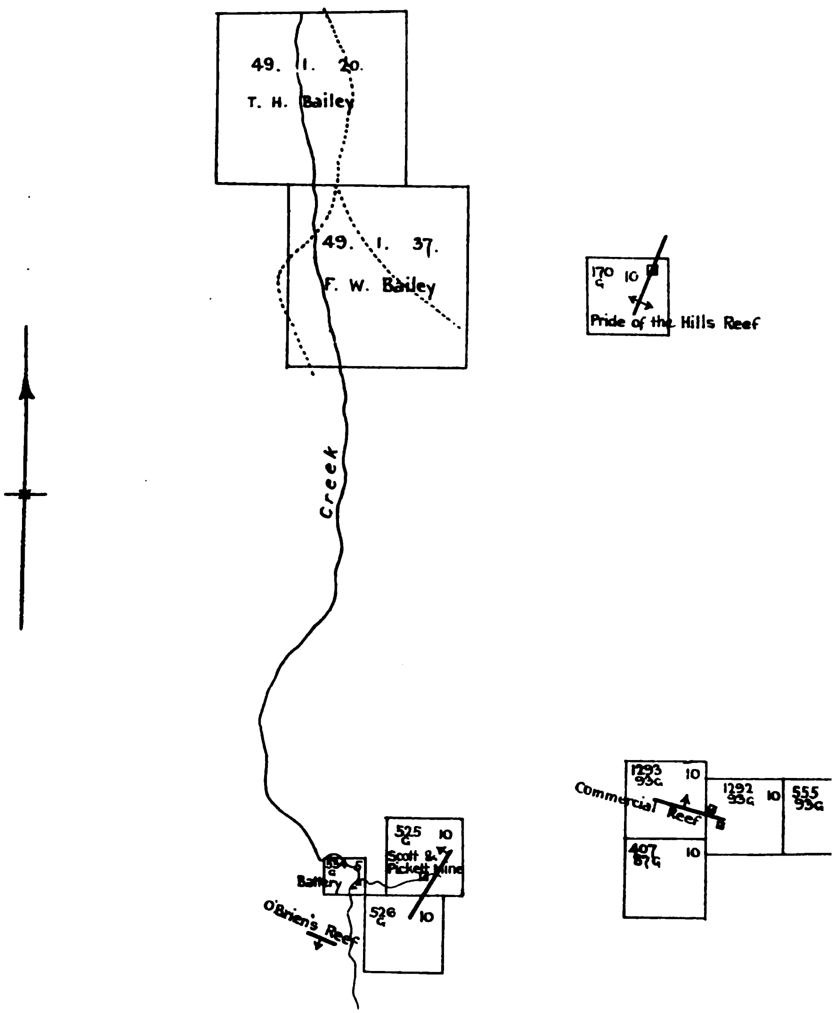
JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

PLATE

LOCALITY PLAN OF REEFS

Scale
10 5 0 10 20 30
of Chains

W. H. Twelvetrees
Government Geologis
December 1907.



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Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 3

THE MOUNT FARRELL MINING FIELD

BY

L. K. WARD

Assistant Government Geologist

Issued under the authority of the Hon. [illegible], Minister for Mines

Hobart:
JOHN VAIL, GOVERNMENT PRINTER

1908

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TABLE OF CONTENTS.

PAGE

I.—INTRODUCTION.

- (1) General 1
- (2) Geographical Position 2

II.—PREVIOUS LITERATURE ON THE FIELD 2

III.—PHYSIOGRAPHY.

- (1) Topography 3
- (2) Meteorology 6
- (3) Economic Aspects:
    - Prospecting and Exploitation 7
    - Water-supply 8
    - Power 9

IV.—GENERAL GEOLOGY.

(1) THE ROCK TYPES REPRESENTED ON THE FIELD.

A.—The Igneous Rocks:

- (1) The Porphyries and their Associates 9
- (2) The Granite-porphyry of White Hawk Creek 17
- (3) The Granite of Granite Tor ... 19
- (4) The Pebbles of Diabase 20

B.—The Sedimentary Rocks:

- (1) The Slate and Associated Crushed Grit and Conglomerate... 20
- (2) The Massive Conglomerate of the Mt. Farrell Ridge 23
- (3) The White Hawk Sandstones and Limestone 28
- (4) The River Gravels 31

C.—The Metamorphic Rocks:

- (1) The Quartz-mica Schists 31

(2) THE GENERAL SEQUENCE OF EVENTS LEADING TO THE PRESENT GEOLOGICAL STRUCTURE.

- (1) The First Period of Sedimentation 33
- (2) The Intrusion of the Older Igneous Rocks 33

PAGE
(3) The Inversion of these Rocks 34
(4) The Formation of the Newer Conglomerate 35
(5) The Folding of the Region in Late Silurian or Devonian Time 35
(6) The Intrusion of the Devonian Granite 36
(7) The Period of the Deposition of the Ores 38
(8) The Events subsequent to the Formation of the Lodes 39

V.—ECONOMIC GEOLOGY.

(1) The Relation of the Ore Bodies to the several Rock Types 39

(2) The Ore Bodies of Mt. Farrell.

A.—Lead ores:

The Spathic Lead Ores 47
The Pyritic Lead Deposits 48
Other Occurrences of Lead Ores ... 49

B.—Copper Ores:

The Cupriferous Veins 50
Disseminated Copper Ores 50
C.—Ore Deposits other than those of Lead and Copper 51
D.—The Quartz Reefs 51
E.—The Outcrops of Iron Ore 53
(3) The Distribution of Ore in the Lodes 54
(4) The Structure of the Lodes 55
(5) The Strike and Dip of the Lodes 57
(6) The Alteration of the Wall-rock of the Lodes by Mineral-bearing Solutions ... 59
(7) The Secondary Alteration of the Lodes ... 61
(8) The Underground Waters 62
(9) Summary of the Genisis of the Lodes ... 64

VI.—THE MINING PROPERTIES.

(1) The North Mount Farrell Mining Co., N.L. 66
(2) The Mount Farrell Mining Co., N.L. 73
(3) The Murchison River Silver and Lead Co., N.L. 79
(4) The Murchison Extended Co. (Late North Murchison) 85

PAGE
(5) The Mackintosh Copper and Gold Mining Co., N.L. 86
(6) The Farrell Blocks 89
(7) The Sections on the North-west Flank of Mt. Farrell 91
(8) The Tullibardine Co. 92
(9) The White Hawk District:
  (a) The White Hawk Mine 96
  (b) Other Sections 99
(10) The South Murchison Silver and Lead Mining Co., N.L. 99
(11) The other Sections North of the Murchison River 101
(12) The Thomas' Blocks Silver Mining Co., N.L. 101
(13) The Tullah Silver and Lead Mining Co., N.L. 103
(14) M. Donoghue's Sections, 2863 and 2864 105
(15) The Sections in the Sterling River Valley ... 107
(16) Other Sections South of the Murchison River 108
(17) The Sections on the Northern Slopes of Mt. Murchison:
  (a) The 40-acre Sections, 2865 and 2866 109
  (b) The 80-acre Sections, 3070 and 3071 109
  (c) The Barytes Lode 110
(18) The Eastern Sections on the Murchison River:
  (a) The Osborne Copper Blocks 111
  (b) Foy's Lode 112
  (c) Kittson's Workings 113
(19) The Sections on the Pieman River 114
VII.—CONCLUSION 117
KEY TO PLATE II., SHOWING THE AREAS AND LESSEES OF THE MINERAL SECTIONS CHARTED 119

LIST OF PLATES.

I.—Locality Plan ... ... To face Page 1
II.—Geological Map of the Mount Farrell Mining Field } At end of Report.
III.—Section across Mount Farrell ... ... } At end of Report.
IV.—Plan of the Workings of the North Mt. Farrell Mine ... ... } At end of Report.

THE MOUNT FARRELL MINING FIELD.

[Four Plans.]

I.—INTRODUCTION.

(1)—General.

In the Mt. Farrell mining district, with which this bulletin deals, the writer has been allotted, for purposes of geological examination, a field which has recently attracted no little public interest.

The district can hardly be said to be a new one. It is rather a field to which the prospector has returned with fresh vigour.

The North Mt. Farrell Mine has been exploited with ever-increasing energy, and its output has been materially increased within the last few months. The faith thus expressed in the future of that property has done much towards the general expansion of the mining industry throughout the district.

The favourable condition of the metal market during the year 1907 also materially aided the work of prospecting; and, as a result, during the early months of 1907 there were floated two new propositions on the southern side of the Murchison River, viz., the Tullah and Thomas' Blocks; also, the first-discovered silver-lead mine of the district, T. H. Farrell's old reward claim, was reopened under the name of the White Hawk.

Besides these properties, which are being actively prospected, there have also been discovered other occurrences of ore at both the northern and southern ends of the field. The future of these latter discoveries will depend very largely on the success of the present prospecting operations.

During my visit to the field two fresh finds were made; and this fact serves to indicate that the district is still receiving the active attention of prospectors.

The position of Mt. Farrell—at the northern end of a series of districts notable for their mineral wealth—is also such that additional interest is attached to its geological examination.

The attempt has been made to define the features common to these several districts, so that they may serve as an indication that, where they recur, prospecting work may reasonably be expected to meet with reward; and this portion of the results of a geological examination must be that which is of more permanent value and wider interest. Special attention has therefore been given to the genesis of the lodes, the general types to which they conform, and their relation to the rock-formations of the district.

(2)—GEOGRAPHICAL POSITION.

Mt. Farrell is situated at the point where the Murchison and Mackintosh Rivers unite to form the Pieman River. The latter finds its outlet to the ocean on the western coast of the island.

Measured in a direct line, the mining field is 35 miles from the coast-line, and it is about 4 miles east of the Emu Bay Railway line.

Mt. Farrell is situated north and a few points eastward of the main West Coast range, of which the culminating peaks are known as Mts. Darwin, Jukes, Huxley, Owen, Lyell, Sedgewick, Tyndall, Read, and Murchison.

The metalliferous belt of the western coast is found to follow closely the trend of the mountain range. The mining fields have therefore a meridional trend; and Mt. Farrell is the most northerly of a series of districts in which copper, gold, silver-lead, and zinc are represented by their several ores. From its geographical position, therefore, the district of Mt. Farrell demands considerable attention.

The only means of communication at present is by the Emu Bay Railway line. A horse tramway connects with the railway at a point 21 miles south of Guildford Junction. However, there is now in course of construction a steam tramway, which, when completed, will materially shorten the present route to the Emu Bay Company's line, and provide a more efficient means of transport to the mining township.

II.—PREVIOUS REPORTS ON THE FIELD.

The first occasion on which an official visit was paid to the field was in the early part of the year 1895, when Mr. A. Montgomery, then Government Geologist, passed through the northern portion of the district, and visited the properties now known as the Tullibardine and the White Hawk Mines.

It was Mr. Montgomery who gave the name of Mt. Farrell to the "rugged rocky range" (up to that time unrecorded), as a tribute to the undaunted endurance of the pioneer prospector of the district—T. H. Farrell.

At the time of Mr. Montgomery's visit no mineral discoveries had been made on the slopes of Mt. Farrell itself.

The report, therefore, of that gentleman on the area contains only his notes on the two properties above mentioned, and some short references to the general geology of the district.

In June, 1900, Mr. Twelvetrees made a short inspection of the district and the mines which were at that time in active operation. His visit was of only one week's duration, and necessarily too brief to admit of any detailed examination of the geology of the area. This report, which contains detailed accounts of the condition of the several mines at that period, is dated from the Government Geologist's Office, on 20th December, 1900.

The next visit paid to Mt. Farrell by a member of the geological survey staff was in March, 1904, when Mr. G. A. Waller made a brief examination. Mr. Waller's remarks on the general geology of the district are of great value, on account of his intimate acquaintance with the geology of the other mining fields of the West Coast range.

Mr. Waller draws attention to the fact that at Mt. Farrell there are found members of the same rock types as occur along the main axis of the West Coast range in an unbroken line from Mt. Darwin northwards. He suggests that the schistose igneous rocks of the district be termed "porphyroids," after the strikingly similar schistose porphyries of Europe. Of this matter more will be said later, when the rocks are treated of.

With regard to the massive conglomerate which forms the main mass of the ridge of Mt. Farrell itself, Mr. Waller's remarks are of particular interest. This formation has been studied by him in several localities on the West Coast, and he concludes that it should be referred to the base of the Upper Silurian. Formerly, it had been considered that the conglomerate was of Devonian age. Of this, also, further mention will be made in a later portion of this report.

III.—PHYSIOGRAPHY.

(1)—TOPOGRAPHY.

The topography of the area is due primarily to the forces which have tilted up the strata to high angles, and secondarily to the natural denuding agencies which have developed the rugged outlines of the surface.

The ridge known as Mt. Farrell is long and very narrow, and owes its character to the nature of the central hard band of siliceous conglomerate. This weather-resisting formation rises at the top of the mountain abruptly from the softer rocks with which it is in contact to a maximum height of about 1600 feet above the junction of the Mackintosh and Murchison Rivers.

The outlines of the surrounding heights are different. Mt. Black, to the west, has well-rounded outlines, and the spurs spread out into the valleys on all sides. Mt. Murchison, which towers above all the surrounding country, shows a series of abrupt cliff faces, with long-graded slopes stretching away on either side.

To the west of the Mt. Farrell ridge lies a broad alluvial plain, which runs back far up the valley of the Sterling River, which occupies the depression between Mt. Murchison and Mt. Black. Its northward continuation is the valley of the Mackintosh River, which joins the Murchison at Mt. Farrell, and flows away westward towards the coast as the Pieman River.

Again, on the eastern side of the Mt. Farrell razor-backed ridge, lies a broad flood-plain—that of the Sophia River—which gathers in the waters of the White Hawk Creek, and joins the Mackintosh River at the northern extremity of Mt. Farrell.

The Murchison River differs from these other rivers in that it has cut its way right through the conglomerate ridge, and now makes its way north and west to join the Mackintosh a little below its junction with the Stirling.

The area drained by these rivers is very considerable, and they are never dry, although the variations in the amount of water passing along their channels are considerable with the seasonal changes.

At Mt. Farrell the average river level is a little over 100 feet below the flat surface of the button-grass plain which marks the old level of the flood-plain.

The region has been elevated since the establishment of this flood-plain, and the river systems are still actively engaged in once more cutting down their beds to the base level of corrosion.

The ancient flood-plain of the Mackintosh River affords some evidence to prove that the uplifting of the region was not effected by one simple movement, for there are still traces of two river terraces left in the undenuded river wash at a point a little north of the town, and west of the Mackintosh Mine.

On the steep banks, also, of the White Hawk Creek, above the old workings of T. H. Farrell, there are terraces of this old river wash.

This elevation of the country is not restricted to the particular region in question, for there are raised beaches at several points on the West Coast. At Strahan, the Tertiary beds are known to form raised beaches, and numerous terraces of gravel are recorded. Mr. Montgomery, in his report on the Corinna Goldfield in 1894, claims that these gravels are of marine origin. However, whether of fluviatile or marine origin, the present elevated position of these gravels is indisputable proof of elevation. It may be that the period of this upward readjustment was Post-Tertiary, and followed upon a Tertiary subsidence. Raised beaches of recent sediments have been recorded at Cox's Bight by Mr. Twelvetrees,* and it may be that some parts of the western portion of Tasmania are still undergoing elevation.

The age of the alteration of level in the Mt. Farrell area is not to be definitey determined from the evidence now available.

There is some evidence in the district which may be regarded as indicative of glaciation. In the neighbourhood of the White Hawk Mine there are very large rounded boulders of granite to be seen. These have been undoubtedly derived from the Granite Tor mass, but are now some miles distant from their source. They may possibly have been rounded in beds of the mountain torrents, but they now occur stranded high above the present creek beds. I noticed several on the flanks of Mt. Swallow, 1000 feet above the level of the White Hawk Creek bed at the mine.

These boulders certainly have the appearance of glacial erratics, but no other of the phenomena usually to be seen in glaciated areas were noticeable.

Mr. R. M. Johnston, in his paper entitled "The Glacier Epoch of Australasia,"† correlates the evidence of these boulders with that of the moraines, roches moutonnées, &c., of many other places to prove a former glaciation of the western highlands of Tasmania.

Taken in conjunction with other evidence, it may be admitted that these rounded boulders are true glacial erratics, and that the region has been subjected to ice action, yet the topography of the area has not been seriously modified by such ice action. If other traces of glaciation were impressed upon the district they have since been obliterated by the action of other surface agencies, unless perhaps Lake Herbert represents a rock basin gouged out by the ice action.

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* **Report on Cox's Bight Tinfield, December, 1906.**

† **Royal Society of Tasmania, 1893.**

The topography, therefore, of the Mt. Farrell district as a whole is that of an elevated region in which the erosion cycle has once reached maturity, but of which the features are now suffering a more rapid alteration, for a comparatively recent alteration has taken place in the general level of the district, and in consequence the river systems have been rejuvenated.

(2)—METEOROLOGY.

The rainfall at Mt. Farrell is undoubtedly very heavy, although no statistics can be adduced to give an idea of the actual amount of precipitation. The following figures, taken from Walch's Tasmanian almanacs, show the total rainfall for a period of 12 months at some of the principal points on the West Coast of Tasmania.

Mt. Read is quite close to Mt. Farrell, but its elevation is considerably greater.

Total Rainfall 1st October to 30th September.

	1899–1900	1900–1901	1901–1902	1902–1903	1906–1907
Mt. Read	—	—	77·91	83·61	126·95
Zeehan	101·33	106·00	94·50	105·31	100·33
Mt. Lyell	94·48	131·20	114·53	118·71	117·23
Waratah	88·03	90·33	73·3	94·48	109·40

The township of Mt. Farrell is said to possess a milder climate, and a drier one, than other spots on the West Coast, on account of its sheltered position. Nevertheless, the annual rainfall is considerable, and is not very evenly distributed. The winter and spring are said to be the wettest seasons, while from the middle of December until March fairly fine weather is prevalent.

Of this rainfall, during the rainy seasons by far the greater proportion must run off the steep surface slopes to the rivers. The snow that caps the highest peaks lingers for a time, and then augments the supply of water to the mountain torrents.

Some small proportion of the rainfall must be held continuously by the surface mantle of soil and peaty growth. The so-called " button-grass " plains and slopes retain their dampness long after the rain has ceased by the action of this vegetable growth; otherwise, the return of the rain to the rivers is rapid, and the rise of a river is to be noted almost instantly after the rain has been observed to fall.

This heavy rainfall on a country of steep slope must necessarily cause a very considerable amount of rock-waste to be carried away downhill to the rivers, and prevent the accumulation *in situ* of any weathered rock-masses. The only retarding agent tending to arrest this downhill movement is the dense vegetation of the district, which exerts a strong binding influence on the surface-mantle of soil; and in the case of the button-grass growth, the whole of the underlying material is covered and protected from the denuding agents.

On the western slopes of Mt. Farrell the whole surface-soil can be seen to be creeping downhill where sections of the surface-soil are exposed by the numerous trenches cut there. The cleavage planes of the slates, which dip to the west in the undisturbed ground a foot or two below the surface, are seen at the surface dipping to the east. The slate is soft and cleavable, and it has been pushed so far by the general soil-creep that the dip of its cleavage planes is inverted.

(3)—THE EFFECT OF THE TOPOGRAPHIC FEATURES ON MINING.

Prospecting and Exploitation.—On the whole, the topography of the district may be said to be very favourable to the exploitation of the mineral belt. The steep grade of the western slopes of Mt. Farrell along which the mineral belt runs has indeed prevented the accumulation of the rich gossanous material which often caps the silver-lead lodes of other mining fields. In fact the downward soil-creep has in many cases quite covered up all traces of an outcrop, although the lode lies only a few feet below the present surface.

But the creeping surface-soil forms only a very shallow layer, since it is removed almost as soon as it forms, so the prospector has not much overburden to remove in most cases when trenching for the lodes.

The creeks cut across the country on these western lodes, and have therefore aided the prospecting of the main portion of the field very considerably.

On the other hand, on the south side of the Murchison River, the streams, on the whole, flow in a more northerly direction as they leave the northern slopes of Mt. Murchison, and run with the strata, rather than across; yet the

Tullah lode was picked up in a stream flowing westward from the slopes of Little Farrell.

Both the White Hawk Mine and the Tullibardine owe their discovery to the existence of these natural sections afforded by the creeks.

The Murchison River itself has cut across the rock-formations and laid bare several occurrences of ore, both of lead and of copper, to which reference will be made later.

Once located, the lodes have been readily exploited by adits driven into the sides of the mount; and these adits, driven towards the central core of the mountain, are usually nearly at right-angles to the strike of the lodes. The north Mt. Farrell Company owes the discovery of its "No. 1 lode" to its lowest level adit, which intersected this body of ore, which does not extend upwards as far as the surface. In fact, the aid afforded to mining by the physical configuration of the country will be apparent when it is remembered that there is not a shaft on the field that serves for the raising of ore to the surface.

Water-supply.—The narrowness of the ridge at the top of Mt. Farrell, and the steepness of the slopes, cause one serious drawback. In consequence of the small area exposed, and the rapidity with which atmospheric moisture leaves the mountain sides, the rainfall, heavy though it is, is, on the whole, insufficient to supply the needs of a mining community of the size of Mt. Farrell, if dependence is to be put only upon the rainfall on the western slopes of the mount.

At the present time there are only two concentrating mills on the field, and of these one is inactive.

The North Mt. Farrell Company's mill is supplied with water issuing from the underground workings of its own mine, and the Mackintosh; but this is inconsiderable in amount. The supply is augmented by a pipe-line that has been constructed to the top of the mount to carry down the waters of the small lake on the southern crest of the ridge. This lake is of small extent, covering only 10 acres, and its catchment area is also small, so that the present demands on its contents are all that can be met. The dry season of the year, for about three months after Christmas time, renders this lake supply a doubtful one for a plant in continuous action.

Races are cut to tap the several streams on the mountain side, but these, too, are apt to fail in the dry season, and the water from underground alone is left.

As regards the mines situated away from the Mt. Farrell ridge: On the south side of the Murchison River no concentrating is being done at the present time. In the event of developments underground warranting a milling plant, the machinery site will undoubtedly be chosen on the banks of the river. And indeed any concentrating mill of the future will need to be built on the river banks or in immediate proximity thereto.

As regards the White Hawk and Tullibardine properties, the water-supply offers no difficulty, should operations at these mines create the demand.

Power.—The configuration of the country is such that, were the quantity of water sufficient, all necessary machinery could be actuated by hydraulic power.

The North Mt. Farrell Mine utilizes its lake supply to drive a 9-foot Pelton wheel, and generates thus a part of the power necessary for driving the concentrating machinery. The lake supply is conveyed from the syphon by pipes and races to the top of the ridge, and thence descends direct in a pipe to the mill. At present this pipe is not full to the top, so that the available head could not be ascertained. A reservoir chamber is needed at the top of the ridge of such capacity that it can carry enough water to maintain a full head for the two shifts during which the mill is running.

The White Hawk Mine is very favourably situated as regards both water-supply and the available head at which it could be delivered with small expense, for the White Hawk Creek drains a large area of country and descends to the mine by a very steeply-graded gorge with several waterfalls.

IV.—GENERAL GEOLOGY.

(1)—THE ROCK TYPES REPRESENTED ON THE MT. FARRELL FIELD.

The various rock formations which require description will be treated of under three heads—

(*a*) The igneous rocks.
(*b*) The sedimentary rocks.
(*c*) The metamorphic rocks.

A.—THE IGNEOUS ROCKS.

There are several groups of igneous rocks on the field, each of which must be looked at separately.

(1).—*The Porphyries and their Associates.*

The first group to be considered is the acid-intermediate series, of which so many different facies are present. These are all gradations from the granitoid varieties south-east of the main ridge of Mt. Farrell, to the porphyries and felsitic types further westward. On consideration of the many features shared in common by all these types, I feel convinced that they are to be taken together as one geological group.

The Holocrystalline Types.—The track from Mt. Farrell along the eastern bank of the Murchison River to the sections in the south-east affords several exposures of a medium-grained basic granite, or syenite, which merges by insensible gradations into a green porphyritic felsite, to be described later.

This syenite—showing to the naked eye equidimensional constituent crystals of dark-green biotite mica and hornblende, pink orthoclase felspar, and the pale greenish felspathic mineral, with an indistinct cleavage—appears like a granite, but the poverty of quartz in the rock is plainly apparent.

Microscopically the rock appears to be a fairly normal syenite, altered by dynamical stresses and masked by reconstitution. The hornblende still remains here and there in idiomorphic crystals, but most of it is altered, and its place taken by chlorite and epidote. The same alterations have taken place in the case of the biotite. In one section I noticed a mineral which appeared to have been augite, but was almost wholly altered into chlorite.

The felspars are clouded by kaolinization, and the plagioclase more so than the orthoclase. The latter has a faint reddish tinge in thin sections. As regards the exact member of the plagioclase series present, I was unable, through the decomposition of the rock, to obtain satisfactory extinction angles.

Quartz is present here and there in graphic intergrowth with the orthoclase. Apatite is common in stout unaltered idiomorphic crystals.

In crystallization, the plagioclase seems to have preceded the hornblende, while the orthoclase was subsequent to it.

The crushing has subjected all the minerals to a state of strain, and has even produced actual fracturing in many cases. Where the minerals have withstood crushing without actual rupture, and where they remain sufficiently undecomposed, their extinction is "shadowy" or "wavy."

These rocks are found in the southern and south-eastern portions of the field, at the Osborne Blocks, and at Kitson's. On the Section 2940, in the name of H. J. Kelly, a variety occurs that may be termed a true granite, from the greater prevalence of quartz.

The Felsitic and Porphyritic Types.—Intercalated with the sedimentary rocks all through the district are a series of porphyritic rocks which appear to me to correspond in general composition to the holocrystalline members above described, but to have consolidated under different physical conditions. By a series of chemical analyses this matter could be settled, but in the meantime the question cannot be definitely decided.

The southern portion of the field will, by reference to the geological map, be seen to consist very largely of these rocks, which form broad zones or very narrow bands in the slate.

From point to point their mineralogical constitution can be seen to alter even in the same continuous belt of rock. A felspar porphyry thus can be traced into a quartz porphyry or into a fine-grained felsitic rock wherein no crystals can be distinguished by the unassisted eye, and the texture is quite homogenous.

Variations in the structure are equally gradual. The uncrushed rocks are comparatively easily distinguished without miscroscopic aid, but in the field these simple types are found to merge into the schistose varieties so gradually that no divisional line can be drawn between the crushed and uncrushed portions; and uncrushed blocks of irregular lens-like shapes occur, quite surrounded by the crushed types.

Again, in the field one is often in doubt as to whether the cleavable schist under observation belongs to the igneous series, or whether it is a variant of the associated sedimentary rocks. In such cases the weathered surfaces of the schist afford some information, since the quartz crystals of the rocks, which were originally unmodified quartz porphyries, often resist the weathering agents that gradually disintegrate the rest of the rock, and so stand out in relief. In this way I found several doubly-terminated quartz crystals left in relief on weathered faces or edges.

By weathering these rocks have their appearance considerably altered in most cases. The aspect of the massive varieties is least affected, and the surfaces are clean and smooth where there is no surface-soil above. At one point, on Section 2864, the progress of weathering on the massive rock, which has an elaborate system of small joint planes developed in it, has produced a rude spheroidal structure.

In some localities, notably near the mouth of No. 4 tunnel on the North Mt. Farrell Mine, and a little to the east of the Langdon Mine, the rock weathers to a honeycombed aggregate, which has all the appearance of a lava with its vesicular cavities caused by the expansion of imprisoned gases at the moment of solidification. Some specimens were so full of these cavities as to resemble a pumice.

It is on evidence such as this that the conditions under which the rocks solidified are to be determined. That is to say, it is possible to judge whether these felsites and porphyries were true *effusive* rocks which poured out on the surface as lava flows, or whether they were *intrusive* rocks which forced their way between the other rocks which were already formed, by the observation of these peculiarities.

By the microscope it can be shown that these felspar porphyries near the North Mt. Farrell workings carry filled vesicular cavities. These are apparent on weathering as empty elongated spaces. The unweathered rocks show in this section these vesicles filled with calcite chlorite, and often a layer of chalcedonic silica.

The vesicles thus filled are considerably elongated, but always in one general direction. This evidence, when taken together with that of the presence of fragmental igneous rocks (to be described later), seems to me to point with certainty to the existence of volcanic action within but a short time of the period of sedimentation, during which the slates were formed.

None of these vesicular rocks were observed to the east of the slate series. They are always on the western side; and on Section 3263 at least the igneous rock was clearly intrusive into the slate, for tongues of the igneous rock can be seen protruding into the slate.

The western boundary of the slates would therefore seem to have been, in all probability, on the horizon of the former surface. The original surface is now tilted to a high angle by subsequent warping.

The effusive rocks which poured out on this surface would then be the surface representatives of the plutonic syenites and granites, and the intrusive porphyries.

A further sign of rapid cooling, such as would take place at the surface, was noticeable in the rocks close to the horizon of the tuff. In one thin section the microscope reveals a ground-mass of extremely fine grain, showing a considerable number of roughly concentric cloudy markings. These are, in my opinion, caused by the progress of weathering along the perlitic cracks caused by the rapid cooling of a rock, once glassy, but since devitrified.

The schistose varieties of this igneous series weather to a grey rock with a very rough surface, especially where the edges of the planes of schistosity are exposed. The uneven hardness and resistance to solution are the causes of the rough surface, and on these weathered edges it is sometimes possible to distinguish uncrushed idiomorphic crystals of quartz.

One feature of some persistence, and especially noticeable wherever the schistose igneous rocks are found, is the occurrence of very numerous veinlets of quartz traversing the members of this series in every direction. The quartz is often coloured pink, and the veins consist in many instances of small crystals, whose longer axes are at right-angles to the length of these numerous intersecting cracks. The width of these veins of crystalline and massive quartz is small, the great majority being under half an inch wide, and very seldom are veins of over an inch met with. The silica has not been deposited solely in the veins, for it has in many instances thoroughly impregnated the rock, and caused it to assume the character of a chert.

This silicification, which is evidently of later origin than the rocks in which it forms so prominent a feature, took place after the main crushing of the region had been effected. For the veinlets are usually undisturbed in the schistose varieties of the porphyries. It is true that there are several occurrences of the fracturing and contortion of these veins, and in some cases I found the quartz crystals of the vein-filling deformed by a movement of the walls to which they are attached. However, these cases are exceptional. The elaborate fracturing of the porphyries may have been caused by the crushing forces which induced the schistosity, but the filling of the fractures with silica was for the most part of later date.

Microscopically these rocks show many features of interest, and of value in determining their relationships.

The massive porphyries display best the original mineral constitution of these rocks, for the development of the schistose structure has been attended by a reorganization of the molecules, and the original character is very largely masked.

The phenocrysts most common in the least altered types are of quartz and plagioclase felspar. Orthoclase felspar is present but not common, and of the plagioclase series the more acidic members are the ones commonly found.

Sericitization and mechanical deformation have in many cases made it impossible to determine the felspar which is present. But the low values for the extinction angles, when measured from the albitic lamellæ, render it clear that the plagioclastic felspars are commonly of the composition of oligoclase. Secondary albite is often present in small clear crystals in the reconstituted ground-mass.

The orthoclase is more frequent where quartz is present in addition to the felspathic phenocrysts.

In no cases are the felspars quite fresh, and they are frequently almost completely replaced by sericite or a quartz-albite aggregate.

The quartz appears sometimes with its crystal outlines well developed, but has more usually suffered corrosion by the magma, and has its boundaries embayed. Very seldom is the quartz free from the "shadowy" extinction consequent upon a state of strain.

Ferromagnesian minerals are rare, and never free from alteration; but in one specimen collected from near the Tullah town-side there was well defined hornblende only slightly chloritized. I also noticed a mineral, which may have been a pyroxene, present in the felspar porphyry of the Langdon section. In a few slides there are chloritized remains of a mineral which seems to have been biotite before its alteration.

Epidote is common all through the series, and is usually to be seen in granular aggregates.

The ground-mass is sometimes little altered, and is a fine-grained micro-felsitic aggregate, which has corroded its way into the phenocrysts.

There is no visible sign of fluxion, save for a slight tendency of the felspars to arrange themselves with their longer axes in one general direction. The quartz phenocrysts, being more equidimensional, do not exhibit any such tendency. The proportion of phenocrysts to groundmass is very variable.

The crushed varieties of these rocks are clearly of this group as regards origin, when seen in thin sections, however widely their microscopic characters may vary from those of the typical porphyries.

The chief variation introduced by the crushing is the development of a wavy banding throughout the rock. This closely resembles the fluxion structure often visible in this class of rocks, due to a movement of the magma during the process of crystallization. Here, however, the uncrushed types show no such fluxion structure in any of the thin sections prepared for examination, and the banding is, in my opinion, of later date than the solidification, and due to dynamic stresses.

In the much-crushed types the phenocrysts have been shattered, and the fragments drawn out into *augen*, or they show signs in polarized light of being in a condition of considerable physical strain. The ground-mass becomes entirely changed into a quartz-albite-sericite aggregate, in which the sericite is strung out in wavy zones, and in some varieties a considerable amount of calcite is present in addition.

Chlorite is also common, especially in the rocks associated with the holocrystalline varieties at the Osborne Blocks and near Kittson's. It is sufficiently abundant to impart a deep green tint to the rock, which resembles anything but a quartz porphyry to the unaided eye. The chlorite in thin sections is strongly coloured, and is extended in wavy lines in much the same way as the sericite of other varieties.

Summing up the evidence collected with regard to these rocks, we may say that they all belong to one series of intrusives and effusives.

Their mineral composition indicates that they are not, in very many cases at least, typical quartz porphyries and felspar porphyries, but rather quartz keratophyres and keratophyres; for there is an almost constant predominance of the sodic over the potassic felspars.

With the description given here of the rocks of Mt. Farrell it will be interesting to compare the notes of Messrs. W. H. Twelvetrees and W. F. Petterd on "The Felsites and Associated Rocks of Mt. Read and Vicinity."*

Many of the rocks there described are identical with those from the Mt. Farrell district—occurring, as they do, in one continuous belt with these.

The crushed varieties of these keratophyres may well be termed "porphyroids," since they correspond in all respects to the rocks originally thus named in Germany. In fact, Professor Rosenbusch, the eminent petrologist, after examining some of the rocks of Mt. Read, has written:—†

"Undoubtedly we have here strongly dynamically altered forms of the acid eruptive rocks. The typical porphyritic structure, the nature of the phenocrysts, the still-recognisable fluidal structure, the nearly entire absence of dark constituents, the occasional spherulitic forms still recognisable in their replacement products (quartz, albite), all point with certainty to members of the quartz porphyry family, and, with great probability, not to quartz porphry in the narrower sense, but to quartz keratophyre and keratophyre. . . . The rocks greatly resemble our German occurrences in Westphalia, the Fichtelgebirge, and Thüringen, and especially the occurrence in Wales. These are the forms which in Germany were originally called porphyroids and flaserporphyries."

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* Proc. Roy. Soc. Tas., 1898-9, pp. 33-46.

† *Ibid.*, p. 43.

Mr. Waller, in his report of 1904, proposed the term "porphyroid" for the schistose rocks of this series. It has been adopted, to some degree, by the mining community, but is used quite without discrimination. The present detailed description of the schistose porphyries has been given in order to give a greater degree of definition to the term "porphyroid," and to indicate clearly the exact meaning of this word, which is used in the later portion of this bulletin. The rock is an important one in the Mt. Farrell mining field, and with the slates forms the common country rock of the lodes. Associated here and there with the green quartz porphyries of the Osborne Blocks are types which seen to be only variants from the rocks of this series, yet which are remarkable for the presence of actinolite.

One of these, from Section 2145, on the western side of the Murchison River, was examined microscopically, and proved to be an actinolite rock.

The actinolite showed tints varying from pale yellow to pale brown and pale green. Beyond the actinolite, which occurs in the form of allotriomorphic crystals or radiating bunches, there is only scattered iron ore and a sporadic prism or two of epidote.

The relation of such a rock to the more acidic members of the series is not clear, especially as no information was to be gained from the field occurrence. It may be that this type is merely a more basic segregation from the normal magma; but such a suggestion can be little more than a speculation in the present state of our knowledge of the district. The outcrop whence the described specimen was obtained was in proximity to the workings marked in the map. Hence it is possible that the actinolite is due to a local alteration of the quartz felsite by the agency of mineral-bearing solutions. And in this connection it may be mentioned here that coarse actinolite accompanies the occurrence of galena some distance to the south, on Section 2865.

The Fragmental Types.—On the extreme western flank of Mt. Farrell, at a point near the south-western corner of the northern section of the Mt. Farrell Company's leases, is a very remarkable rock, which appears to be an altered volcanic tuff. It is in immediate contact with the felspar porphyry which shows the vesicular cavities filled with chlorite calcite and chalcedony referred to above, but the actual junction could not be traced on account of the surface cover. The western continuation of this rock is entirely covered by the button-grass plain at the foot of the mount.

In appearance the rock is, on the whole, deep green in colour, but with grey and reddish blotches irregularly distributed. The varying splashes of colour are due to angular fragments, which are of different composition—some chalcedonic, others apparently fragments of the pink-coloured uncrushed porphyries.

At the junction of the Mackintosh and Murchison Rivers, still further to the west, a very similar rock is to be seen here and there; and the tramway cuttings afford sections which show that the fragmental varieties pass by quite insensible gradations into the massive porphyroid. We may look upon them as the fragmental porphyroids, or "clasto-porphyroids."

With microscopic aid it is still more apparent that these rocks are certainly fragmental, and yet possess many features in common with the other porphyroids.

The felspar crystals embedded in its mass are very considerably altered, with a great development of kaolin and epidote. In some the original crystal is replaced by an albite-epidote mosaic, with more or less silica and calcite in addition. The interstices between these altered crystals are filled with a mixture of chlorite, epidote, calcite, and kaolin.

In one slide there was visible an angular fragment of a glassy igneous rock. This piece seems to me to afford certain evidence of the shattering of an effusive rock by volcanic action. The glassy fragment is stained pale brownish by decomposition, but still shows a number of clear microlites possessing a straight extinction; and it possesses, in addition, a well-developed perlitic structure, which has been accentuated by the progress of weathering.

(2)—*The Granite Porphyry of White Hawk Creek.*

The sedimentary rocks of the White Hawk district—sandstone, limestone, and pebbly grit—have interbedded with them a dyke rock, which is a true "microgranite," or "granite porphyry."

It forms a broad dyke, which dips westward with the sedimentary rocks and outcrops on the eastern boundary of the leases.

The rock has a felsitic ground-mass, which is sometimes pink, sometimes green, and in which the porphyritic crystals of quartz felspar and biotite are set.

It is clear that considerable alteration has taken place since the rock first solidified—even to the naked eye. There is a considerable development of chlorite, by which in some cases the ground-mass, in others the felspars, are almost replaced by the secondary green mineral.

Where undecomposed the felspars are fairly large and pink.

Microscopically it is a typical microgranite, which is free from the effects of dynamic metamorphism, but altered by weathering. The ground-mass is a fine granular aggregate of quartz and orthoclase, in which are phenocrysts of quartz, biotite, orthoclase, and plagioclase.

The quartz has suffered considerable corrosion by the magma, and its borders are ragged, and sometimes deeply embayed. The felspars are also corroded, but not to the same degree as the quartz. The biotite shows usually its crystal outlines, and basal sections appear as cleanly cut hexagonal plates.

Decomposition has altered the biotite almost completely into chlorite—sometimes massive in form, at other times in tufted radiating aggregates.

The felspars are kaolinised or sericitized, and in some cases the decomposition has been attended by the introduction of iron and magnesium, and finely-divided chlorite penetrates the crystals. Epidote is present in small amount.

All through the ground-mass there is finely-divided chlorite, which imparts the prevalent green colour to the rock. The definite determination of the felspars is difficult, inasmuch as their alteration leaves little more than bare traces of original structure in most cases. They are quite commonly zoned, and both single and multiple twinning are still recognizable.

Whether this microgranite belongs in origin to the magma which has produced the plutonic mass of Granite Tor, or whether it is another variety of the series above described, cannot be determined from its mode of occurrence.

It lies in position between the two varieties of the igneous rocks, and nearer to the granite on the east.

The great distinction between members of the two groups is that the series already described all show more or less the effect of crustal movement.

Yet in the White Hawk area all of the rocks are noticeable for a freedom from the signs of mechanical deformation in a district of such considerable disturbance.

In age there is but little difference between the two groups of igneous rocks, so that the relative progress of decomposition is not of value as a criterion in distinguishing them.

The granite porphyry here described is quite uncrushed, the alterations that have been effected being simply the result of the work of surface agencies.

(3)—*The Granite of Granite Tor.*

On passing up the valley of the Mackintosh to the northward, an examination of the river gravels shows an ever-increasing proportion of pebbles of a holocrystalline rock quite different in type from the syenitic granite above described as occurring with the porphyries.

This other is a typical coarse-grained acidic granite in most specimens. Both muscovite and biotite micas are usually present, but some varieties show an almost complete absence of biotite and abundant silvery-white muscovite. The rock is coarser in grain than the syenitic granite of the Osborne Blocks, and often carries porphyritic crystals of orthoclase as much as an inch and a half in length.

This is the rock which occurs *in situ* at Granite Tor, and which has many features in common with all the other tin-bearing granites of Tasmania. Tin is reported to have been derived from this granite also.

Microscopically viewed, the rock is perfectly free from all signs of dynamic metamorphism.

The felspars, both orthoclase and plagioclase, are in a fair state of preservation, and only kaolin has resulted from their alteration. Their crystal outlines are well defined, and they have clearly preceded the quartz in crystallization. Muscovite and biotite are abundant, and the latter is sometimes chloritized.

This plutonic mass of granite appears to dip underneath the mica schists on its western border, and probably is connected in depth below the Mt. Farrell field with the other granitic outcrops of Mt. Heemskirk and the Meredith Range.

(4)—*The Diabase Pebbles.*

Among the pebbles which constitute the beds of the Murchison River and tributaries are some well-rounded ones of medium-grained diabase. This rock does not appear anywhere in the district *in situ*, and the pebbles must have travelled many miles from the eastward mountains by the agency of the surface-streams, and perhaps to some extent of glaciers. They are frequent in the pebble beds of the modern streams and in the older river deposits intersected by present streams or exposed by mining operations.

The diabase is known to occur *in situ* at Barn Bluff and at the Eldon Range, from both of which waters now flow westward by the valley of the Murchison; so these pebbles are probably derived thence, and have reached their present position by the transporting agency of the steep-graded streams.

B.—THE SEDIMENTARY ROCKS.

(1) *The Slate and Associated Crushed Grit and Conglomerate.*

These form the main sedimentary series of the central portion of the mining field; and although the lodes are not confined to the zones in which they are found, yet the productive lodes at the present time are situated in these old fragmental rocks.

There are all gradations—from the conglomerates, against which the harder and massive conglomerate of the central ridge of Mt. Farrell abuts, to the fine-grained slates further to the west. The grain is coarser on the eastern side of the belt than on the western.

The coarse varieties are easily recognised by their rounded pebbles of quartz, many of which have resisted the crushing forces. Some of the pebbles are drawn out into "eyes," and the whole rock structure is altered. The crushed grits of grain intermediate between that of the conglomerates and the true slates are at times very difficult to distinguish from the porphyroid, especially from the more markedly schistose varieties of the latter.

All varieties of this series show unmistakable signs of crushing, and the attendant reorganization of their contents, so that they cleave readily into flakes. The coarse kinds part in roughly parallel directions, while those of finer grain show a clean slaty cleavage for the most part.

At a few points in the neighbourhood of fracture-planes there has been an impregnation with silica, and the slates become hard, massive, and non-cleavable.

Where mining operations have penetrated these slates and exposed them it can be easily seen that there has been considerable alteration of both the structure and composition in the immediate vicinity of the lodes. The No. 4 tunnel of the North Mt. Farrell Mine has penetrated the altered zone, and runs far into the unaltered slate beyond. This latter at this place is a dark cleavable slate with fine-grained iron pyrites along the parting-planes. I could not perceive any visible graphite in the slate; yet where the lodes traverse the rock the appearance of graphite is noticeable, and the iron-bearing mineral is the carbonate, not the sulphide.

The structure of the slate near the lodes is also different. The even slaty cleavage is replaced by a remarkable contortion and brecciation of the whole rock. The cleavages appear to dip in any direction, and the lines of parting often appear intricately folded, fractured, and overthrust. These phenomena indicate that much of the stress which produced the fractures now filled with ore must have been of the nature of compression.

The majority of the rocks of this series are dark in colour, but there are some associated light-coloured rocks which, in my opinion, are to be classed with them.

To the west of the lode-bearing slates in the Mt. Farrell, North Mt. Farrell, and Mackintosh areas is a narrow strip of this pale clay schist or slate. The belt is distinguished from the ordinary slate in the geological map and section herewith.

At the North Mt. Farrell Mine there is a narrow belt of the dark slate still further to the westward; but in this case, as in all other visible sections along this belt, there appears to have been some degree of movement between the light and dark slates at their contact. The relation between the two is therefore not definitely certain on the evidence available. The persistence of the belt will be seen by reference to the map to be remarkable. I traced it northward as far as the Mackintosh River in Section 2909. Southward the rock is to be seen near the mouth of the main lower-level adit of the Mt. Farrell Mine, and extends till it is hidden by the button-grass plain.

An entirely similar rock is the country rock of the Tullibardine copper property, where it is obviously interlaminated with the dark slates on either side.

In the South Murchison section the eastern tunnel has been driven in a pale-coloured slate of a somewhat similar appearance. Here the pale slate is interlaminated with the darker, the junction being visible at the mouth of the adit. Between the ordinary dark slate and the paler variety there is no unconformity nor any plane of separation. The colour changes abruptly, and the slaty cleavage becomes less well marked.

The rock from the Mt. Farrell Mine was sectioned, and shows a number of small quartz granules strung out in wavy lines, and between them undulating bands of sericite and kaolin.

A specimen from the South Murchison section was also examined microscopically. It showed an even more homogenous texture. The sericitic bands are so fine as to be nothing more than strings. Calcite has made its way in along the planes marked by the strings of sericite, and forms eyes here and there.

With regard to the structural features of the members of this series, a very strong distinction should be made between the bedding-planes and cleavage-planes.

The two are being constantly confused on the field; and may lead to serious misunderstanding of the geological structure.

The slates especially are very seriously contorted at times, and the cleavage-planes are always the prominent feature, whereas the bedding-planes are not visible at all in the great majority of instances. In fact, it is an extremely difficult matter on this field to determine the dip of these sediments, when the beds are considered as a whole. The mining operations have given one or two exposures of the divisional lines between the members of the slate series and between the porphyroid and the slate; but in all such cases there has apparently been some degree of movement between the two rocks in contact, and the passage of meteoric water along these planes has masked the relationships of the rocks. In such cases as were open to observation the dip of the rocks seemed to be to the westward, and at an angle of from 60° to 70°.

At the South Murchison Mine the contact line between the pale and dark slate is nearly vertical, but inclining to the west.

The planes of schistosity dip almost always to the west, but there are great local contortions of these rocks, both near the lode fractures and in the unproductive zones; for instance, above the workings of the Farrell Blocks, on Section 2397, the planes of schistosity strike north-west and south-east, whereas their normal strike throughout the field is parallel to the main axis of the Mt. Farrell ridge.

(2)—*The Massive Conglomerate of the Mt. Farrell Ridge.*

The core of the Mt. Farrell ridge is a rock which in its typical development is a coarse conglomerate, but with which are interbedded finer-grained sandstones, or even shales. These rocks are obviously all members of one great period of sedimentation, and must be treated of together.

The conglomerate is usually of a pinkish colour, and almost wholly quartzose in composition. The pebbles consist of all varieties of quartz—massive, banded, and chalcedonic—and of a quartz schist or quartzite schist. This latter schist is nearly all quartz, with very little pale-coloured mica, and the layers of mica are often contorted.

The cementing medium in the conglomerate is also siliceous, and usually very small in amount when compared with the large bulk of the rock that is composed of the pebbles. The sandstones also are almost wholly of silica, and are stained red by oxide of iron.

The strike of the beds is practically the strike of the mountain ridge, but it varies widely at one point near the fault-plane which traverses Section 2796.

The bedding-planes are not decipherable where the massive form is met with, and neither strike nor dip can be ascertained; but the coarser type passes over abruptly into the finer, and the structural relations become visible. There is a band of the finer-grained sandstone running the length of the mountain, from the south end to the fault-plane, almost on the very centre-line of the ridge; and on the eastern slopes, towards the valley of the Sophia River, the finer-grained sediments can be seen outcropping here and there through the button-grass.

The southern end of Mt. Farrell shows a great local thickening of the conglomerate, and a south-east spur of the mountain, which extends along the eastern bank of the Murchison River, is wholly of conglomerate and its associated sandstone.

The Murchison River breaks across the conglomerate at the southern end of the mount, and on the south side of the river the same beds are to be seen as on the northern; and "Little Farrell," as the portion south of the Murchison River is called, has the same general aspect as the larger part on the other side of the river.

Viewed from the top of the southern end of the mount proper, the structure of Little Farrell is plainly visible. The same massive beds of coarse conglomerate are apparent, with the interbedded sandstone, but the finer-grained varieties of the eastern slopes of Mt. Farrell are not seen on the southern side of the river.

The structural features presented by the rocks of this series are of some interest, as they assist considerably in explaining the structure and geological history of the district.

The strike of the main series of beds varies from N. 5° W. at the south end of the mount to N. 10° W. above the Farrell Blocks trenches; and approaching the fault-plane, whose strike line has a bearing of 112°, the strike of the finer beds is continually making towards the westward, till it bears N. 45° W. Northward, beyond the fault-plane, the strike is N. 10° E.

At the southern end of the mount, where the spur runs out in a south-easterly direction, the strike-lines follow the spur round till their bearing is N. 30° W.

The dip of the beds which form the ridge of the mount, above the chief mining centre of the field, is practically 90°, and as the ridge passes southwards this vertical structure of the main beds is preserved.

The finer-grained beds on the eastern fall of the mount are mostly covered by button-grass, but appear to dip to the west.

Passing northwards, the main series of conglomerates acquire an inclination to the eastward as the fault on Section 2796 is approached, and on the south side of the fault dip east at 80°. Across the fracture-plane the structure is different. The more westerly members of the conglomerate series lie at an angle of 30° with the horizon, while the eastern beds, from the centre of the ridge eastwards, dip east at 70°.

The change of dip is abrupt, and I think it is due, not to a movement of the crust after the formation of the whole series, but to a tilting of the region during the process of sedimentation.

The main fault that intersects the series is a dip-fault, and its effect can be clearly seen from Innes' track along the foot of the mountain on the western side.

The weathering of the bent strata and the breaking-off of blocks of rock across the joints and bedding-planes makes the sediments, when viewed from the track, appear to dip east on the west of the ridge at the south side of the fault gorge, and lower down on the same cliff faces to dip to the westward. However, the writer's observations showed that the dip was always to the east, or rather north-east.

The conglomerate series rests unconformably upon the complex of slates, porphyries, and porphyroids, with an unconformity between the two formations. The best position for observing this contact is from the south end of Mt. Farrell, and looking across the gorge of the Murchison River at the cliff section exposed on the southern side.

The vertical beds of coarse conglomerate on the western boundary of the series abut directly against the crushed conglomerate, which is the coarsest facies of the older crushed sediments. The divisional line is very sharply defined, and the older conglomerate has its planes of schistosity dipping away to the west at an angle of about 70°. The conglomerates are seen to continue right down into the bed of the river.

From the south side of this gorge, and looking northward, the beds appear vertical at the top, and yet as they approach the river seem to bend slightly and dip a little to the east. The inaccessibility of this portion of the mountain on the north side of the gorge prevented me from verifying this distant observation at closer quarters.

The conglomerate certainly comes right down to the river at this point, but the vast amount of boulders which have been broken away by the surface agents of decay and disintegration completely hide the actual contact of the conglomerate and the adjacent rocks at low levels. For the hard siliceous fragments broken away from the mountain crest do not easily disintegrate to form fine rock waste that can be borne away by the rivers, and accumulate at the foot of the gorge as a jumble of angular blocks of all shapes and sizes.

From the point where the river cuts through it, the conglomerate thins out on the south side, and disappears altogether not far to the east of the Tullah property.

At the northern extremity of the mount the same difficulty is experienced in finding the relations of the conglomerate to the rocks on which it rests, for the fragmental blocks conceal the junction.

The mountain seems to be split in two at its northern end by a strike fault. I could not find the actual fracture-line, for the cover of button-grass conceals everything. A trench on the gap between the two bluffs of conglomerate shows the underlying rock to be of the slate series, and one or two outcrops of slate appear on the slopes of the gap leading down to the river at the extreme north end of the mountain. The western portion of the conglomerate here seems to have been separated from the eastern by a fault. If so, the fault has the effect of producing an increasing downthrow of the displaced portion as we go north. No trace of the split is to be found southwards, and the conglomerate is, on both sides of the gap at the north extremity of the mountain, of the most massive type, so that the bedding-planes cannot be distinguished.

The conglomerate bluffs weather to bold, bare, rounded knobs, and support no vegetation. The button-grass has crept up high on the slopes, and even covers part of the ridge, but on the whole the outcrop is bare and sharply defined.

Fragments of all sizes of the conglomerate occur along the valleys of the Mackintosh and Murchison Rivers. These are, for the most part, just blocks which have reached their present position by the relative lowering of the rest of the region by the action of the rivers.

However, I noticed some large boulders, notably some of several tons weight near the Farrell Siding, distributed here and there at all altitudes throughout the district.

In a region whose river systems have been continually undergoing modification, these blocks may have reached their present places by river action, but there remains the possibility of comparatively recent glaciation to account for the distribution of these as erratics.

This conglomerate is similar in character to that which forms a capping on so many of the West Coast mountains; and in all probability the beds at Mt. Farrell belong to the same period of sedimentation as the other entirely similar conglomerates. However, there are, of course, many breaks in the continuity of the series, yet none so great that they cannot be explained by the existence of either original breaks or gaps since formed by crustal deformation and surface degradation.

With regard to the origin of the conglomerate at Mt. Farrell, there are several points of interest to be considered.

It has been stated that the massive type consists almost absolutely of well-rounded pebbles of quartz, and that these are considerable in bulk when compared with the interstitial sand and cement.

This uniformity in the composition of the pebbles, their general uniformity of size by the sorting-out of the finer material, the considerable regularity of the stratification along the original strike-line—all these argue for a local derivation by the action of the sea.

Contrast with them the pebble-beds forming at the present time in the channels of the Murchison and Mackintosh Rivers, and these features, especially the uniformity of size and composition of the pebbles, will be the more apparent.

The absence of pebbles of the porphyries and syenite seems remarkable, for the conglomerate admittedly overlies the complex of slates and porphyries uncomformably, so that these latter might well be expected to have contributed towards its bulk.

The quartzite and quartz schist pebbles seem to have undoubtedly been derived from the great masses of these rocks on the eastern side of the valley of the Sophia.

One is inclined to suppose that a tilting of the region took place at the time of the formation of the conglomerate which brought the sea-level to a line at the base of these quartzites, and below which the slates and porphyries were so far submerged as to be beyond the range of wave action. I am not aware of the nature of the rock formations which lie east of the quartzites, other than the mica schists (to be mentioned later) and the granite of Granite Tor.

Whatever be the mode of the origin of the conglomerate, there have been some changes since its formation. The tilting referred to above, and the fracturing of it, are subsequent; and in addition to these major movements, there has been a minute shattering of the whole series, and a later infiltration of silica. The whole of the formation is characterized by a complex of small intersecting veinlets of silica, which often cut through the pebbles and cementing matter as well, and the matrix seems to be rendered more dense by a siliceous impregnation.

With the silica is a certain amount of specular hematite. In spite of some rumours to the effect that galena was present, the only metallic mineral I found was this hematite.

At the level of the track passing through the gorge cut by the Murchison River, at the south end of the mount proper, there seems to be a tendency for the conglomerate to assume a schistose habit.

This is no doubt due to the stresses that have produced the tilting, and supports the idea that the beds have been bent upwards rather than that the whole series has been tilted as a block, and supports also the observations made from Little Farrell with regard to the structure of the series as a whole.

(3)—*The White Hawk Sandstones and Limestone.*

The White Hawk district, at the north-eastern extremity of the area examined, consists of a series of sedimentary rocks intruded by the granite porphyry dyke rock above described.

These sediments consist of three formations—a bed of limestone lying between a sandstone on the west, and a sandstone which has coarser pebble-beds interstratified with the finer material on the east.

The upper sandstone (western) of the series is fairly uniform and fine in grain. The dip is apparently in harmony with that of the other associated beds, viz., westward. The dip angle is 47° where it junctions with the limestone, but rises to 75° on the western boundary of the central White Hawk lease. The strike is about 10° east of north.

These beds proved fossiliferous at a point north-west of the original outcrop of ore discovered by Tom Farrell. The fossils have been referred to Mr. Robert Etheridge (Jun.) for description, and the remarks of that gentleman on them are appended.

The limestone is a massive one of a dark bluish-grey colour, wherein part of the calcium carbonate has recrystallized. On weathering the surface of the rock becomes irregular from inequalities in the rate of solution, but the ridges found on a weathered surface show no signs of organic structure. The bed at its lower side where it rests upon the lower sandstone has a westward dip of about 40°.

There are very perfectly developed joint-planes, of which the best-marked series dip eastward at an angle of from 50° to 60°. The action of surface-waters in dissolving out portion of the carbonate along these joint-planes renders their presence very prominent near the surface, and the rock seems at first sight to be dipping eastward.

As is usual in limestone areas, there are many cavities of solution visible at the surface, which have been gradually enlarged until they form caves. Most of these lead down into the heart of the rock through the progress of rock-solution along bedding-planes.

Their influence on the mining has so far not been serious, for the work done has been at shallow depths. The White Hawk Creek, at the mine, is running on the limestone just at its junction with the lower sandstone, and the water cannot but be a great hindrance to future working at a greater depth.

The drainage from the hill to the west of the mine also can be seen to find its way in part by underground channels to a lower level.

The lower sandstone formation consists of a series of normal sands and a course pebbly grit. Portions of the formation, especially on its lower side, have been silicified into quartzites.

The thickness of the whole series is only from 130 to 150 feet, but as the slope of the eastern side of the creek gorge almost coincides with the dip of the rock the thickness appears to be much greater.

Fossils were obtained from this horizon also, and with the others from the upper sandstone were submitted to Mr. Etheridge, whose remarks are:—

"I have examined the specimens referred to in your letter, and although very poor impressions, I believe them to be as follows:—

"(*a*) Sandstone below White Hawk limestone contains impressions of one of the varieties of *Rhynchonella borealis*, Schlotheim, a well-known and widely-spread Silurian species.

"(*b*) Sandstone above White Hawk limestone contains many impressions of the brachiopod I have from time to time identified from Tasmanian strata as *Rhynchonella capax*, Conrad, and named var. *meridionalis*, and still believe to represent that species. In America it is one of the fossils characteristic of the Hudson River Group."

So the age of this sedimentary series is definitely fixed as Silurian.

There are two points of interest in the geology of this area when considered together with the rest of the district. It is noticeable that the coarser sediments—the pebbly grit referred to above—are on the extreme east of the series where the formations rest against the granite porphyry. This feature is in harmony with the relationship of the older crushed sediments—slate and crushed conglomerate—to the structure of the district.

Further, the still more noticeable feature of these rocks that distinguishes them from the other rocks of the district is the freedom from the signs of intense crushing.

While it is true that the small area here considered has not yielded to the intense crushing to the same degree as the rocks to the west and south-west, the series must have had a very great pressure to withstand; for to the west lie the slates and porphyroids, that bear witness to dynamical stresses in the immediate neighbourhood.

The whole block of country of which these strata form but a portion may have successfully withstood the crustal movement, and though the rocks have been tilted their particles may not have been forced over each other and drawn out in lenses. The nature of the rocks is such that the crushing stresses could have left but little traces; yet the block may have been part of the " foreland " against which the crushing of the other rocks has taken place.

But even so, the proximity of the highly altered rocks to the west makes one reflect further on the remarkable preservation of the original characters.

In my opinion the simplicity of the chemical composition of the sandstones and limestones has had a good deal to do with the absence of alteration.

Contrasting these rocks with the porphyroids we see a chemical composition of marked simplicity as against the equally marked complexity of the constitution of the igneous rocks.

Mention has already been made of the fact that all the members of the syenite-felspar porphyry series are probably very closely related in chemical composition, although their texture and mineral constitution varies continually. And these variations are beyond doubt due to varying physical conditions imposed upon the different facies at the time of their solidification. A variation of the physical conditions after consolidation, namely the subjection of the rocks to intense lateral pressure, has caused a secondary readjustment of the molecules, and the reorganised porphyries become porphyroids.

The several minerals of secondary origin, notably epidote, calcite, albite, and quartz, all take their origin by variations in the physical conditions to which the rocks are subjected.

But in the case of rocks that are almost wholly composed of calcium carbonate or of silica, no such molecular readjustment is possible. The originally finely divided calcium carbonate may crystallize and form a crystalline limestone, but no further change can result.

(4)—*The River Gravels.*

The only remaining sedimentary rocks of the district are the river-bed deposits, for the most part unconsolidated. The present rivers have cut their way down through an older alluvial accumulation that bears strong resemblance to that forming in the flatter reaches of the rivers now. The broad plain that lies at the foot of the western flank of Mt. Farrell is dissected here and there by streamlets that make towards the present-day rivers.

The deposits of this old flood-plain are a series of beds of gravel and sand, with the coarser beds at the bottom and the finer above them. The pebbles are of all sizes, and of very varying composition, although the quartose ones predominate. Many of these have undoubtedly been set free from the conglomerate of the ridge of the mount; and there are pebbles of the conglomerate itself containing several of the older pebbles and their cement all smoothed down together to form the single pebble of to-day.

These river alluvial deposits are restricted mainly to the broad plains through which the main rivers run, but I also came across a few small terraces on the White Hawk Creek which were formed of river gravel.

C.—THE METAMORPHIC ROCKS.

The alterations that have been effected by regional metamorphism in the rocks of both sedimentary and igneous origin have already been described in dealing with those groups.

There remain only some types whose unaltered state is now not so clear that we can trace the nature and degree of alteration from the original condition.

The Quartz Mica Schists.

These metamorphosed rocks form a fringe along the eastern boundary of the district, and are of chief interest in that they have contributed so largely to the formation of the massive conglomerate of the mountain.

Their relations to the slates are not to be seen on account of the broad flood-plain of the Sophia River and its dense cover of button-grass. However, there seems to be some definite continuity between them and the sedimentary series of the White Hawk district.

The writer was able to make no more than a cursory examination of this outer fringe, but it may be well to record the observations that were made.

Ascending the north-western spur of Mt. Swallow, which rises from the White Hawk Creek at the mine (see the sketched locality plan), the granite porphyry becomes a little finer in grain, and then a white quartzite is met with, which contains a little pale mica here and there.

The massive quartzites and the micaceous varieties or quartzitic schists seem to be inextricably intermixed, and their extent towards the east is considerable—about 2 miles. The only mineral contents of this belt with which I met were a small blow of hematite on the Mole Creek track, on the north-west side of Mt. Swallow, and a little disseminated arsenical pyrites further south.

Following the Mole Creek track eastwards the quartzite gives way on the eastern side to a broad belt of rock, which becomes more and more micaceous. Bands of the almost pure quartzite recur, but the rock here is normally a mica schist, which in some places becomes so fine in grain as to resemble a normal slate. These mica schists are quartz-biotote-muscovite aggregates, and show some local contortion of the bands. The planes of schistosity usually dip west.

This rock continues right up to the acid granite of Granite Tor, and seems to overlap the granite at the contact. Southwards from Mt. Swallow the Mole Creek track passes over the same quartzites and quartzite schists, and the bare bluffs on the eastern walls of the valley of the Sophia River are of the same material.

The granite porphyry is met with on the track a good deal further east than the White Hawk occurrence, and the quartz mica schists also seem further east. On the present visit I was unable to determine whether the strike takes a south-easterly bend on passing south, or whether the granite porphyry widens on its southward continuation, or whether a dip-fault has displaced the series.

The only other occurrence of similar rock types in the field is at a point between the White Hawk Mine and the Tullibardine.

A series of low, sharply defined ridges, running a little east of north, on the eastern side of the Mackintosh River, are formed of a dense quartzite, which carries a little pale green mica.

The western scarps of the ridges are very steep, and are covered with disintegrated blocks of this quartzite. This boundary suggests that there is a fault-plane striking north and south, but the button-grass completely covers all the surrounding country. To the east lies the upper sandstone of the White Hawk series, and to the west are the slates of the Tullibardine area, but the junction-lines are invisible, and the presence or absence of any intervening strata undetermined.

(2)—THE GENERAL SEQUENCE OF EVENTS LEADING TO THE PRESENT GEOLOGICAL STRUCTURE.

The following are the principal events which have succeeded each other in the area under consideration. They are presented in the order of their occurrence, as far as can be ascertained from the study of the rocks themselves and their field relationships.

1. *The First Period of Sedimentation.*—The series of sedimentary rocks, of which the slates of Mt. Farrell form the most considerable portion, appear to be the oldest rocks on the field. The passage from a conglomerate on the east through grits to the slates on the west seems to indicate a gradual submergence of an old basin. The old floor on which these sediments were laid down is not now recognisable; unless it be the quartzites and mica schists which outcrop on the eastern side of the valley of the Sophia River.

As regards the age of the slates, it can hardly be fixed as yet. Lithologically their resemblance to the Dundas slates is marked. These latter are fossiliferous, and of Ordovician age. But at Mt. Farrell no fossils have been recognised in this formation.

The slates may quite possibly have been contemporaneous with the sediments of the White Hawk area, now known from fossil evidence to be Silurian.

2. *The Intrusion of the Older Igneous Rocks.*—While it may be that these rocks are, in part at least, older than the slates, the writer considers the bulk of the evidence points to their later appearance.

The rocks which now appear as diverse types seem to me to belong to one great series, and to have resulted from one magma. The syenites, quartz porphyries, felspar porphyries, and their schistose derivatives show a remarkable difference between the south-eastern and the western portions of the district. In the former there are the holocrystalline types, between the two are the evidences of intrusion into the slate series, and on the west are the volcanic members. The suggestion at once presents itself that we may have here the various phases of a great intrusion of igneous material, of which the portion which remained far below the surface solidified and formed the holocrystalline syenites. Portion may have spread laterally in the form of sills through the slates, and another portion again may have reached the surface to form lava-flows and volcanic tuffs.

It is certainly possible that the intercalated sheets of porphyroid were contemporaneous lava flows; but some of them are certainly intrusive, and some also are effusive.

At least two horizons of the fragmental type of porphyroid were detected—one near the main road of the Tullah township, and one at the junction of the Mackintosh and Murchison Rivers. The great thickness of the porphyroid to the west of the slate appears to be due to a great succession of lava flows.

The relations of these igneous rocks to the slates will always be somewhat obscure, on account of the subsequent alteration. There are very few visible outcrops of the junction lines, and the distinction between the two groups is sometimes very difficult in the field.

If this hypothesis be correct—and there are no discrepancies between the evidence afforded by either the igneous rocks or the associated sediments—the eastern portion of the field, now at the level of the surface, must have been deeply buried. The coarser sediments of the slate series would thus be the lowest beds of that series, and the syenites typical plutonic rocks.

3. *The Inversion of these Rocks before the Formation of the later Conglomerate.*—The newer conglomerate and its associated finer-grained sediments show a marked structural contrast to the older sediments on which they lie unconformably. The eastern beds in the newer conglomerate are the finer, and the western beds are coarser. And the appearance presented by the conglomerate as a whole gives the impression that the western beds were the first formed of that series. This being so, the whole of the pre-existing formations must have been completely inverted by folding. If the igneous rocks are, as considered by the writer, older than the conglomerate, they must have shared in the folding.

In this tremendous crumpling of the crust a very considerable degree of schistosity must have been developed in the folded rocks, and at a date prior to the formation of the newer conglomerate.

This folding may have produced the fractures which have later served as circulation channels for the metalliferous solutions.

4. *The Formation of the Newer Conglomerate.*—Following upon the lastmentioned folding of the region came the submergence of the area and the formation of the conglomerate (and the sandstones of the same series).

The submergence may have been such that most, if not all, the igneous rocks were below the reach of wave action, and if so the absence of pebbles of these rocks would be accounted for.

The age of this rock formation is considered by Mr. G. A. Waller to be Upper Silurian.* He refers the red conglomerates of the West Coast to the base of the Upper Silurian, since the fossiliferous strata of the Upper Silurian period rest conformably on them at Zeehan.† Also on Mt. Jukes the sandstones interbedded with the conglomerate contain Upper Silurian fossil remains.‡

There are sediments of Upper Silurian age in the White Hawk area of the Mt. Farrell district; but their relation to the massive conglomerate of the mountain is not yet known.

During the formation of the conglomerate and its accompanying sandstones there was at least one further tilting of the region. For the eastern beds at the northern end of the mount are not conformable with the western. The eastern beds dip towards the western, but there is no folding. I believe the change of dip is purely an unconformity, not a synclinal fold. At all events, I could not see any repetition of the coarser beds, as might have been expected if a fold were present.

South of the fault which traverses Section 2796 the dip of the eastern beds is less easily recognised, on account of the cover of button-grass on the east side of the ridge.

5. *The Folding of the Region in Late Silurian or Devonian Time.*—After the formation of the sediments of Upper Silurian age, the region suffered yet another lateral thrust. Under the stress the crust was again buckled, and the tendency of the movement was to restore the older sediments (of the slate series) to their former position.

The conglomerate of Upper Silurian age was by this movement tilted almost upon edge, for the greater part of its extent at Mt. Farrell.

A great fracture occurred during or after this folding, and is marked by the fault plane near the northern extremity of the mount. And the rocks south of the fracture plane have been pushed to a higher angle than those to the north of it.

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* G. A. Waller: "Report on the Mt. Farrell Mining District," 1904, pp. 2 to 6.

† *Ibid.*, p. 4. ‡ *Ibid.*, p. 6.

This crustal movement would undoubtedly cause the development of a schistose structure throughout the region, and all rocks of greater age than this period would be affected by it. The conglomerate appears but little affected. The slates and igneous rocks, which may have already, as explained above, been rendered schistose, would have their schistose character still further intensified. The direction of the strike of the planes of schistosity in general conforms to the axial strike of the mountain, although local variations do occur.

At this period, if not at a still earlier date, the shales became slates. The pebbles of the older conglomerate were drawn out, and a schistose mantle formed round the felsitic rocks. The holocrystalline rocks, too, were crushed, but the signs are less apparent.

Accompanying the minute crushing there may have been developed at this period some at least of the fractures, which later became impregnated with metallic ores. The siliceous rocks of the mountain, the conglomerate and sandstone, are fractured in all directions, and are recemented by a later infiltration of silica.

The sedimentary rocks of the White Hawk area are tilted, but otherwise unaffected, except perhaps by the development of a few fractures, the position of which is very hard to determine.

6. *The Intrusion of the Devonian Granite of Granite Tor.*—The plutonic mass of granite at Granite Tor intruded at a date later than the crushing of the older rocks of the district. It is a granite which is distinctly more acidic in composition than the members of the older igneous series. But still more marked than the difference of composition is the freedom from signs of crushing in this more acid granite.

I was not able on this visit to examine in detail the relation of this granite to the remainder of the rocks of Mt. Farrell and the neighbouring districts. However, in my opinion, it is more than probable that the outcrop at Granite Tor is merely one point where the agents of denudation have laid bare portion of a huge granitic mass which possesses in depth unbroken continuity.

We do know of the outcrop of an entirely similar granite at several other points, namely at Cox's Bight, Heemskirk, the Meredith Range, Hampshire Hills, and the Dove

River. Moreover, at the Renison Bell Mine, near Rosebery—a locality intermediate between the points where the granite outcrops—there are tourmaline-bearing quartz porphyry dykes. In the same neighbourhood, at the Colebrook Mine, there occur the borosilicate minerals axinite, datolite, and danburite. These occurrences both point to the existence of the granitic mass below the surface. For the tourmaline quartz porphyry dykes are the apophyses of such a mass, and the borosilicates are beyond doubt the result of the reaction on the country rock of the boric emanations given off from a cooling granitic magma.

From this it appears that the Mt. Farrell district is underlaid in depth by the granite which appears to the east at Granite Tor and to the west at the Meredith Range and Heemskirk. And the existence of the mica schists lapping over the granite on the sides of Granite Tor supports this view. For these mica schists appear to be sediments of varying grain altered by contact metamorphism, and the granite dips under them where I investigated the junction of the two rocks on the western flanks of Granite Tor.

The period of the intrusion of this deep-seated mass of granite, which has certainly liberated the mineralizers and given rise to the ore deposits at the localities abovenamed, must have been later than the Upper Silurian and previous to the Permo-Carboniferous.

In deciding this matter of age, it is necessary to regard the various outcrops of this uncrushed granite as outcrops of a single geological unit. For my part, I consider that we are justified in doing so. The evidence regarding the age is conclusive, and may be briefly cited under three **heads***.

(1) The rocks of greater age than the Upper Silurian are folded and rendered schistose by the disturbance of the region. The granite in question is free from such foliation.

(2) The granite is known to be intrusive into the ultrabasic igneous rocks of the gabbro, pyroxenite, and serpentine types at Trial Harbour. These ultrabasic rocks are intrusive into the Upper Silurian strata at Heazlewood and Zeehan. The granite and gabbro may possibly be two extremes of differentiation of one original magma; and the granitic veins in the

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* See G. A. Waller: "Report on the Zeehan Silver-Lead Mining Field, 1904," p.p. 11 and 12.

serpentine may be the result of final stages in the consolidation of the one main mass. However, even if this is so, the gabbro-granite magma has intruded into strata known from fossil evidence to be of Upper Silurian age. Also, the granite intrudes into the peculiar sandstone, which has been called the "pipe-stem" or "fucoid" sandstone, at the Dove River, and the River Forth, in the Middlesex district.

(3) On the other hand, the granite is not intrusive into the Permo-Carboniferous strata, but exists in the form of rounded pebbles as a constituent of the conglomerates of that system; and at Ben Lomond the Permo-Carboniferous strata have been observed to rest upon the denuded surface of the granite.

7. *The Period of the Deposition of the Ores.*—After the main period of crushing of the country rocks of the field came the filling of the fissures, which were either already prepared for the impregnation by the previous crushing, or were superinduced upon the crushed rocks by later stresses. We know that this filling of the fissures was of later date than the crushing, as we find fragments of the crushed rocks cemented into the uncrushed lode matter. Yet by this statement it is not intended to convey the impression that all movement had ceased at the time of the filling of the fissures. For it will be seen later that the lodes themselves show signs of movements which have brecciated their metallic contents.

The filling of the fissures must have taken place at more than one period, for there seem to be two distinct types of vein-stuff.

The first impregnation appears to have been a siliceous one, and to have produced quartz-veins free from metallic minerals other than iron pyrites.

Later, there must have been still further strains developed in the rocks of the district, and a fresh set of fractures resulted. Some of these cut across the original quartz-filled fissures, as may be seen in the section exposed by the open-cut of the North Mt. Farrell Mine. It is to this later filling, with its prevalent gangue of iron carbonate, that the productive lodes are due.

The age of the fissure-filling I believe to be that of the intrusion of the Devonian granite; and I believe the introduction of the metallic ores to be due to the intrusion of that mass. It is now a firmly established fact that the later stages of the consolidation of a deep-seated mass of granitic composition are accompanied by the emission of highly heated vapours, which, under such conditions of high temperature and pressure, have the power of holding in solution metallic compounds.

On their expulsion from the igneous rock, and during their ascent into the upper regions of the earth's crust, they experience a fall of temperature and pressure which eventually suffice to cause precipitation of the metallic contents in the channels which are serving at the time to carry the vapours or solutions upwards.

It is, I believe, to the Devonian granite that we must look for the immediate source of the metallic compounds of the Mt. Farrell district; and the age of the impregnation is therefore that of the final stages of the granitic intrusion.

8. *The Events subsequent to the Formation of the Lodes.*—The events of later date than the vein-filling, which have modified the geology of the district, are two in number:—

(1) Further movements have taken place between the already fractured segments of the crust. These readjustments have modified the structure of the lodes themselves, since the former fissures have remained planes of weakness, and the strains have been relieved by their reopening and the differential movements of the walls.

(2) Surface agencies have operated on the region, and carried away much material, and deposited the river alluvials. These agencies have not been uninterrupted by movements of deep-seated origin, for we find the older river flats cut into by the warping of the region since their formation, with the consequent revival of the corrosive power of the streams.

V.—ECONOMIC GEOLOGY.

(1)—The Relation of the Ore-bodies to the Several Rock Types.

When any one single mining property on the Mt. Farrell field is considered apart from the surrounding leases it may appear that the ore-bodies are restricted to a certain lithological group.

In other words, the nature of the country rock may appear to have influenced the lode in the several particulars of width, mineral composition, richness, or even position.

It is a matter of most vital importance to the field that this matter should be carefully considered.

The guidance of the present development work on the mines is not the only point at issue. The whole feature of the district, and the further prospecting for the yet undiscovered lodes, are concerned with the correct interpretation of the geology of the known parts of the field.

And in the examination of these known facts it is absolutely necessary to regard the field as a whole. The several properties are dealt with separately in a later part of this report, and their particular features noted. At present the matter of the lode phenomena exhibited by the field as a whole will be discussed, and the changes in the composition and structure of any one single lode at different points along its course taken into consideration; for the boundaries marking-out the mining sections are artificial, and have no place in the general discussion of natural phenomena.

This matter may seem perfectly obvious, and not worthy of mention; yet it is owing to an exaggeration of the value of local phenomena, and the attempt to make these of general application, that no little energy and capital have been fruitlessly expended on the Mt. Farrell field.

It is an old-established view held by many mining men that the metallic contents of ore deposits have a genetic relationship to the country rocks with which they are associated.

The practical aspect of this statement means that if the country rock, which is usually of great extent as compared with the lodes enclosed in it, and easily found, be sufficiently diligently searched, the possibilities of the discovery of lodes are great; and, moreover, it is held that in some classes of country rock lodes of one composition will be found, and in other rocks there will be lodes of different composition.

It does not seem possible to separate this view from the idea, even if no actual expression is given to it in so many words, that the country rock is responsible for the formation of the lodes; that is to say, that by the action of some process or processes the country rock has actually provided the metallic contents of the lode. The ore-bodies are thus thought to be merely the metallic contents of their country rocks gathered together in a concentrated form.

And there are many occurrences of the metallic ores that lend colour to this view, and which will lead the prospector astray unless he is careful to distinguish between the great classes of the country rocks enclosing within their boundaries the metallic minerals sought by the miner, viz.:—

(*a*) The country rock which is part and parcel of the same rock-mass from which the ores also have been derived, *i.e.*, which has certain definite genetic relationships with the ores.

(*b*) The country rock which has had fissures formed in it by the action of internal or external causes, or which has from the time of its formation held certain cavities which may act in the same way as superimposed fissures.

These cavities, in this class of associated country rocks, supply only the empty place for the lode-filling, which is introduced from without in solution. These solutions are now generally admitted to be ascending hot solutions similar to those which appear at the surface in volcanic regions, or which have been tapped by mining operations.

That they derive their aqueous content, their heat, and the metallic salts in solution from some deeply seated igneous rock is now also admitted by most mining geologists.

The deposition of the metallic ores in the cavities through which these solutions circulate on their ascent, is due to definite physical and chemical laws; the chief causes of precipitation being the decrease of the temperature of the solutions in their ascent, and the lessening of the pressure to which they are subjected.

(*c*) The country rock which has has held disseminated through its mass a certain small proportion of some metallic compound, and from which meteoric waters have leached out the metallic content, once widely disseminated, and have redeposited it in more concentrated form in the larger cavities or fissures.

When once the prospector has realised that these several classes exist, he must learn to interpret the phenomena of the field with which he is concerned, and to decide the class to which the ore deposits of the district belong; for the genesis of the lodes is the most important point to be decided when future operations are being planned.

Applying the above generalities to the case of the Mt. Farrell lodes and their surroundings: The relationship cannot be that of the first class above mentioned, in that we find lodes, whose general similarity will be indicated later, occur in rocks of widely different origin, viz., the slates which are undoubted sediments, and the porphyries or their derived schistose types which are certainly of igneous origin.

Although the occurrences of tin and some other ores, and perhaps even some silver-lead ores, are of this character, the lodes of Mt. Farrell cannot possibly be considered to bear this relationship to the rocks within which they are contained.

It remains then to decide between the other two types.

The criteria by which we are able to judge whether the lode-material was introduced from without, or whether it was gathered together from within the enclosing rock-mass, are several.

Of greatest importance for this purpose are a series of exact analyses to determine the amount and distribution of the metals in the country rock, and the state in which they exist there; that is to say, whether the metal is present uncombined, or in combination with sulphur, or as a constituent of the rock-forming silicates. This work has not been attempted with regard to the field in question; but extremely valuable and laborious chemical work has been performed on other mining fields, from which general conclusions have been drawn.

The great majority of metalliferous lodes may, by the application of these methods, be shown to owe their metallic content to the introduction of the material from sources outside of the immediately enclosing rocks. This is a general statement that is applicable to most ore veins, and the so-called "lateral secretion" theory cannot be made applicable to more than very few mineral occurrences.

In the disproving of the views of the believers in lateral secretion, the most elaborate work that has been done was performed at Freiberg, whose lodes offer several points of similarity in composition to those of Mt. Farrell.

In making the above general statements it is assumed that the lodes of Mt. Farrell do not differ as regards origin from those of other similar mining fields.

There are certain other features presented by the lodes and the country rocks which point to their mutual independence.

Lodes of the same character, possibly even different portions of the same lode, are found to occur in both the massive felspar porphyry and the schistose porphyroid on the south side of the Murchison River. Whether the lode that is now being prospected by the Thomas' Blocks Company extends northward into the slate belt is not determined so far. If it does, the example taken becomes still more instructive, and proves, for that part of the district at least, that lodes are not restricted to the igneous rock and its derived schist.

We know, for the more northerly part of the field, that the productive lode of the Murchison River Mine is in the porphyroid, and those of the North Mt. Farrell mines are in the slate.

It is true that in the case of the Murchison River Mine the presence of the porphyroid seems to be necessary for the existence of the lode. This is one of the cases which calls for further investigation.

In a later portion of this report it will be seen that the Murchison River lode is one the strike of which varies considerably from that of the other lodes of the field, and the course of which cuts obliquely across a narrow belt of porphyroid enclosed within the slate. The productive zone in the lode is restricted, as far as has yet been determined by mining operations, to the zone which is enclosed between walls of porphyroid. The lode-fissure extends beyond the porphyroid band on both the northern and southern side; but it has obviously pinched at each end, and the small amount of prospecting work done in these two directions has not yet disclosed an ore body of sufficient size to be payable.

Yet the lode-channel is continuous, and galena is visible on its track, as well as the siderite which so commonly accompanies the lead ore on this field.

With regard to these phenomena, the writer is strongly of the opinion that the existence of the broad ore-shoot in the porphyroid and the relatively narrow track of the ore in the slate is due, not to the difference in composition between the two rocks, but to the difference in the behaviour of these rocks when they were subjected to the strains which resulted in the fissure now traceable by its ore-filling and the development of characteristic minerals along its course.

There are no two rock-masses of the earth's crust which can be expected to behave in exactly the same way under strains sufficient to produce deformation; and in this case the physical dissimilarity between the two rocks is considerable. The porphyroid at this spot is a very massive type, with few of the markedly schistose characters. It appears to have broken, under the deforming stresses, along a plane, in the same way as a brittle object might break if submitted to such treatment.

But in the case of the slate, the trace of fracture, though quite distinct, is not clean cut as in the porphyroid; it is rather a fracture zone. Moreover, the two walls of the fracture appear to be different in the two rocks where the lode is in porphyroid; the alteration of the country rock and its impregnation with the lode-matter is slight and the wall is clean. On the other hand, the slate carries the lode-material disseminated through it beyond the actual fracture.

All this evidence points to the fracture having been one of actual displacement when it was formed in the porphyroid, and to its having been a " distributive " break in the slate; that is to say, although the total result may have been the same, the single fracture has its place taken by an elaborate system of minute dislocations. This fracturing was of prior date to the utilization of the cavities by the metalliferous solutions.

The nature of the fractures has undoubtedly had a great influence in governing the distribution of the circulating metal-bearing solutions; but beyond this the influence of the country has not been effective in the control of ore-deposition.

Another case that calls for investigation, as it seems to have given rise to a belief that change of country has been accompanied by change of the lode-filling, is that of the copper lode exposed by trenches on the northern section of the Mackintosh leases.

This occurrence of copper is situated in the narrow belt of pale-coloured clay schist very close to the slate boundary. Now, in the same mining section in the south-west corner the slate contains the galena lodes which have been worked, off and on, by tribute parties; and in this case the pale clay schist lies a little to the west of the lodes, so that the impression is given that the lead lodes are present in the slate and the copper in the clay schist.

I regret that no work has been done to try and expose the geological structure between the two occurrences mentioned. Still I am of the firm belief that they are both on one and the same lode-fissure, and that this lode-channel traverses at a very small angle the junction-line between the clay schist and the slate.

The occurrences spoken of are directly in the line of several other outcrops, and it seems to me more than probable that the series are on a continuous fracture system.

As regards the change of composition of the lode-filling with the change of country, the alteration is neither so abrupt nor so considerable as is generally thought.

All through the field there is present, in constant association with the galena, a certain amount of copper pyrites. In all the mines it is noticeable, and at times is found in considerable bunches, even in a mine so free from other metallic minerals than galena as the North Mt. Farrell.

The same variation in the lode-filling is noticeable with respect to other minerals, namely, in the distribution of zinc-blende and the antimonial ores.

The inference to be drawn from these local concentrations of one or other of the metallic minerals is that from point to point along one lode-channel or along the general line of fissuring in the district there have been variations in the relative proportions of the different metallic elements present in the solutions which have brought the ores into the fissures; and these variations have occurred during the primary filling of the fissures, and are not secondary phenomena caused by the leaching-out from the lodes of one or more other mineral constituents, for the variations are noticeable where the lodes are perfectly free from all signs of weathering, leaching, or secondary deposition.

The common feature shared by both the copper and lead deposits on the Mackintosh northern section is the development of siderite as a gangue mineral. This fact affords additional evidence that the mineral-bearing solutions in each case have been of the same character, although the proportion of the metals present has varied.

And still more conclusive is the fact that in the south-west corner of the Farrell Blocks section, north and adjoining the Mackintosh property, there is a lode-formation which I take to be the continuation of this same series, and in which both galena and copper pyrites occur. Here the lead content seems to be once more asserting itself, and is noticeable further north on the Farrell Blocks property, and in the section, No. 2909, further north.

Again, it should be pointed out here that in the case of the prospecting work that has been done on the Tullibardine property a few miles further north, the same alternations of lead and copper ores are to be found; and some parts of this area show both lead and copper occurring together.

Where the two metals seem most cleanly separated from each other on the Tullibardine lease, the country rock is the same—the pale clay schist.

With this evidence of actual facts of occurrence before us, the control of the country rock on the lode-filling can be hardly appreciable, as regards primary ore-deposition; and the Mt. Farrell district does not show any feature which is not open to question in favour of the interrelation of the lodes and the walls enclosing them.

Before leaving this subject there remains the question as to whether the silver content of the galena in the White Hawk Mine is affected by the fact that the lode is in limestone country. I have heard it stated on the field that a high, or even average, silver content could hardly be expected on account of the presence of limestone, and parts of the Zeehan field were mentioned as affording similar instances.

This has been recorded by Mr. Waller, in his report on the Zeehan field (page 17).

It is a question which requires a good deal of detailed investigation before any explanation can be given of the phenomena. As regards the White Hawk property, the ore from which low silver returns were obtained is thoroughly oxidised, and the progress of weathering may alone account for a relative impoverishment in silver.

There is no doubt but that the silver content of the ore would be removed more rapidly than the lead by oxidation and leaching; and I have seen assays of the White Hawk galena which are of normal tenor. Whether these show the average value of the ore remains to be seen. At least some of the ore is not below the average of the field, and it may prove that the low values obtained from the gossans are due to weathering; and in limestone country it is well known that oxidation proceeds to a very much greater depth than in other rocks less permeable to meteoric water.

(2)—THE ORE BODIES OF MT. FARRELL.

It is found that metallic ores are almost invariably discovered grouped together in certain definite associations with each other, and with certain characteristic gangue minerals. These constant associations give a few well-defined paragenetic groups or lode types. And the lodes of Mt. Farrell, while differing among themselves, conform strikingly to some of the well-known lode types.

A.—LEAD ORES.

The Spathic Lead Ores.

Beck defines this type in the following words*:—

"In this class the gangue consists essentially of the carbonates, calcspar, brownspar, rhodochrosite, siderite, and quartz. The ore minerals are argentiferous galena, argentiferous sphalerite, and less often, pyrite, marcasite, tetrahedrite, both with and without silver, together with high-grade silver ores, especially ruby silver and argentite.

"The structure is usually imperfect, and but seldom well branded. The ore minerals frequently occur sprinkled through the gangue."

It is to this type that the main producing lodes of the district belong. The lodes that have been worked on the Mackintosh property, the North Mt. Farrell and the Mt. Farrell leases, all conform closely to the type.

The only feature in which these lodes differ at all from the description of the general type is this—that there is uniformly present in the lead ores a certain amount of copper pyrites, and more of the copper than the iron pyrites.

This copper pyrites is sometimes very prominent in bunches, but usually occurs as small irregular blebs scattered through the lode.

On the south side of the Murchison River the same general lode type is the characteristic one, and the ore of Thomas' Blocks shows the features best.

The Tullah Mine exhibits a difference of lode-structure that may seem to mask its mineral composition, but the same lode type is undoubtedly represented.

To the north of the main productive area, the type again recurs where the lead is found on the Tullibardine property.

With regard to the gangue minerals that are associated with the galena the carbonates are practically always strongly predominant. (Reference is being made here to the lead lodes, not to the barren siliceous quartz reefs.)

There is usually a little silica either restricted to a certain zone or in irregular veinlets and bunches in the gangue.

The carbonate mineral is usually siderite, but minor amounts of calcite, dolomite, and intermediate varieties like ankerite also occur.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 243.

These carbonates containing less iron are noticeably present where the enclosing walls are freer from iron, as where the lodes traverse the pale clay schist or the porphyroid.

The proportion of lead to zinc sulphide varies very much in even the same mine; yet zinc-blende is not such an important mineral as in the sulphidic ore of the Murchison River Mine.

Of the antimonial ores there seems to be a very irregular distribution. They occur rather in pockets and bunches in a lode, the general character of which is quite normal. These bunches usually afford high returns on account of the fahl-ore, which carries silver, as a rule. The occurrence of this class of ore seems most common in the Central Farrell and the Murchison Extended (lately North Murchison) leases, Sections 1980 and 1075.

I have been informed that ruby silver ore has been seen at various times in small amount on several of the mines, but did not meet with any specimens during my examination of the field.

At Thomas' Blocks there occurs, in addition to the carbonates, a small amount of white and purplish fluorite on the walls of the lode.

The Pyritic Lead Deposits.

Beck's description of the type is this*:—

"In the pyritic lead veins, quartz, galena, sphalerite, pyrite, arsenopyrite, and chalcopyrite are most abundant. As accessory constituents of the gangue we have hornstone, jasper, ferruginous quartz, calcspar, siderite; more rarely, brownspar and chlorite . . . The vein-filling has a prevailingly massive structure, in which the vein minerals occur, either commingled or in separate compact masses. More rarely the ingredients are arranged in bands."

To this description the ore of the Murchison River Mine answers almost in every particular. In addition to the sulphides mentioned, pyrrhotite is common. The blende seems the most abundant of the sulphides, but the others all appear predominant in various parts of the lode.

Among the gangue minerals there is usually a little siderite near the walls, but it is inconsiderable; and in one spot in the centre of the formation there was a small clean pocket of barytes. The ore also carries gold in small amount.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., pp. 235 and 236.

Other Occurrences of Lead Ores.

Here and there, on the south-eastern portion of the field are occurrences of galena associated with chalcopyrite, and no traces of walls are visible. The country rock is chloritized quartz keratophyre or quartz felsite, and the ore occurs as scattered blebs in the rock.

These deposits, as far as can at present be determined, do not seem likely to produce much ore.

Yet another type of occurrence is to be seen on the slopes of Mt. Murchison, on Section No. 2865, where the galena is associated with barytes and actinolite, together with calcite and quartz.

This may possibly correspond to the type of veins called by Beck the 'barytic lead veins:"*

"In this class of veins," according to Beck, "the gangue consists of predominant barite, with fluorspar and quartz or jasper, besides calcspar. These minerals are generally intergrown in a remarkably thin-banded structure. The barite especially occurs in finely-crystalline crusts (calcbarite); the fluorspar in diverse tints, but mainly green and yellow. The ore minerals, which either form thin crusts or appear sprinkled through the gangue, consist of argentiferous galena, often developed in large flakes, pyrite and marcasite; also zinc-blende, copper pyrite, gray copper, and at times rich silver ores."

In the occurrence on Section 2865 no sign of fluorite was seen. However, it may have been present, as there was only a very small excavation to examine at the time of my visit.

The gangue is a mixture of quartz and barite, and iron pyrites is associated with the galena. Coarse columnar actinolite is associated with the gangue on the borders of the metalliferous area; but there is far too little done on the work to determine anything more than the presence of the minerals mentioned.

The other occurrence of lead ore is that between Kitson's workings and this last-described deposit. The galena occurs as fine dust-like particles in a very pure barytes. There is no sign of an economically valuable lead deposit here. The barite is treated of in a later portion of this report.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 258.

B.—COPPER ORES.

The Cupriferous Veins.

The most considerable amount of copper present on the Mt. Farrell field is found in veins of a rather strange type, to which some reference has been already made.

In the opinion of the writer, they are closely connected genetically with the spathic lead ores, and are due to variations in the composition of the ore-bearing solutions at different points along the fracture system.

Both quartzose and spathic copper ores are well-known types found in many parts of the world. The occurrences at Mt. Farrell resemble to some extent the spathic ores described by Beck in these terms*:—

> "The gangue of these veins includes some quartz, but often consists chiefly, and sometimes entirely, of various carbonates, particularly ironspar, as well as calcspar and dolomite.
>
> "Barite is very common, and is at times accompanied by fluorspar. The ore minerals are chalcopyrite, bornite, glance, tetrahedrite, and pyrite. Cobalt and nickel ores and various other ores also occur as accessory minerals."

This description applies to parts of the cupriferous bodies at Mt. Farrell; but the usual gangue is almost wholly quartz with small stringers of carbonate, and the primary ore is almost always, if not always, chalcopyrite.

If the views stated above are correct, viz., that these copper occurrences are local variations from a somewhat similar lead type, the gangue is apt to become very much more siliceous where the copper is present.

Both the Mackintosh and the Tullibardine ores are strikingly similar, and are of this character: In immediate proximity to each, galena is to be seen, both alone and in association with the copper pyrites.

Unfortunately, both properties are but little developed, and future operations will afford much more information on this subject.

The Disseminated Ore of the South-eastern Sections.

The Osborne Blocks and the more southerly sections show several minor occurrences of ore which do not appear to be fillings of the usual types of fissures. They seem rather to be lenses of ore disseminated through the somewhat altered country rock.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 226.

One such occurrence on the Osborne Blocks is in immediate proximity to a large blow of hematite; but whether the two have one origin it is impossible to say.

In these cases the copper ore is almost always chalcopyrite. Some bornite is present at times, and fine specks and facings of galena are usually associated with the copper. These remarks apply to the occurrences of the Osborne Blocks, and to some extent to the small pocket of chalcopyrite visible on the slope of Little Farrell on C. Thomas' section. In the latter case there is quartz showing more prominently than in the other cases.

On the northern slopes of Mt. Murchison there is another of these hematite blows which shows stains of copper sulphate where it has been cut by a short tunnel, and the neighbouring porphyroid is flecked with green spots of malachite.

C.—ORE DEPOSITS OTHER THAN THOSE OF LEAD AND COPPER.

Between Kittson's workings, in the section now charted in the name of L. Jolly, and the two 40-acre sections, there is a very well defined reef of almost pure barite, which seems to occupy a fissure of considerable length.

Its possible value as a source of salts of barium is dealt with later.

At Kittson's workings, Section 2829, there are several small veins running in all directions, which contain a mixture of iron and copper pyrites, with some specular iron ore. In addition, at one spot there is a fair quantity of native bismuth and a small amount of a steel-grey sulphide of copper, lead, bismuth, and antimony—probably lillianite.

Some rich silver ore is stated to have come from this spot. The mineral containing it could not be detected in the workings at the time of my visit.

In mentioning other ores it is well to remember that tin ore has been recovered from the granite of Granite Tor not far from the White Hawk Mine.

D.—THE QUARTZ REEFS.

There are some well-defined barren quartz reefs at Mt. Farrell which have caused much waste of time, energy, and capital on the part of prospectors.

By very many on the field they are still regarded as possible sources of lead ore, and this idea is well shown in the term "main lode" applied to one of these reefs on the Mt. Farrell Mine.

A matter of great importance to the central productive portion of the Mt. Farrell field is the correct interpretation of these quartz reefs.

Their definition is usually excellent, as they occur for the most part in the slate, which readily weathers away from the reef or carries numerous "floaters" of quartz to mark their presence.

Their horizontal extent is considerable, and the width sufficient to suggest large bodies of stone in depth; but it is their relation to the lead ores that is the important point to decide.

As regards age, there is excellent evidence to show that the lead veins are of later date than the quartz reefs.

Looking at the face of the open-cut in the North Mt. Farrell Mine from the north, the most striking feature is the clean-cut intersection of the quartz by the lead ore bodies. The "horses" of mullock left standing, in the exploitation of the ore, are belts of slate traversed by very numerous veins of quartz, which dip rather flatly to the west. These veins seem to be part of a more massive body of quartz, which is seen at the surface in more solid form a little further north (at the north end of the open-cut). This body of quartz is typical of the others on the field and here at least is intersected at a small angle by the lead ore veins.

The quartz reefs being older, we may well expect them where fractured to be traversed by the lead ores, and to *contain lead ores where this later impregnation has taken place.*

This is well shown in the case of the Mt. Farrell Mine, with it's rich shoots of ore enclosed in quartz. For on this latter section the quartz body is full of vughs, partly filled in many cases with crystalline quartz. A long line of vughs, connected in depth with the main fissure by which ascending solutions have brought up the metallic compounds, seems to have served as the cavity necessary for the deposition of the ore. Where the continuous line of ore-filled vughs joins the main fissure, or how it is connected, remains as yet unknown. The facts that are certain are—**that the ore is entirely surrounded by quartz**; that other lines of empty vughs occur—empty, because the ascending solutions had no access to them from below—**and that where the lead ore occurs siderite is** always visible, whereas the quartz away from the galena-siderite veinlets is quite barren, and contains only undigested fragments of slate.

The same phenomena are exhibited by similar quartz reefs in slate on the sections south-west of Thomas' Blocks south of the Murchison River.

The fractures which have admitted the filling of quartz have remained, perhaps, still planes of weakness; and during subsequent fissuring and impregnation a fracture parallel with the original one, or even coincident with it, has formed and been filled. But the ore-filling is of a totally different type to the quartz impregnation, and the characteristic mineral of the later invasion of material is the carbonate of iron.

Whether the minute fissuring of the porphyroid and felspar porphyry previously mentioned is a part of the phenomena of, and simultaneous with, the filling of the larger fissures with quartz is not certain from the evidence gathered. However, on the Tullah Mine and at the Langdon the silicified igneous rock has been refractured and penetrated by metal-bearing veinlets; and this impregnation show some close resemblance to the secondary filling of the bodies of quartz. The felspar porphyry has preserved more of its character during silicification than the slate; for the quartz reefs seem to have almost completely replaced the slate, and only small fragments of the latter remain here and there embedded in the solid quartz.

E.—THE IRON ORES.

There is a considerable amount of hematite, of both specular and compact varieties, in many parts of the field. Much specular ore is scattered through the conglomerate of the Mt. Farrell crest in association with the quartz veinlets.

There is on the north-western flank of Little Farrell a considerable mass of the older schistose conglomerate almost completely replaced by a compact red hematite.

Other very massive outcrops appear in the chloritized quartz keratophyre and quartz felsite of the Osborne Blocks; and yet another similar to these is the porphyroid on the northern slope of Mt. Murchison, in Section 3070.

So the impregnation of iron ore is of later date than the alteration of the porphyries, and perhaps of later date than the conglomerate of the mountain ridge. It is certainly younger than the latter if the impregnation of all the rocks has been simultaneous.

(3)—THE DISTRIBUTION OF ORE IN THE LODES.

The internal structure of all the lodes of the field is in most cases very complex, and the ore minerals share in the complexity.

At times there is a distinct banding of the veins, and usually the several bands are parallel to the general direction of the lode. The clean hand-picked "firsts" are obtained from these portions of the lodes. But any one lode will often show both the banded structure and a brecciated structure as well in the same face; and the ore in this crushed portion is usually scattered through the gangue, and the mixture constitutes the average "seconds."

When banded there is not a noticeable alternation of ore and gangue. It is rather a parallel arrangement of galena of varying grain in the majority of cases. In no case did I observe a separation of galena from blende in the banded portions of a spathic vein.

The galena in the pyritic vein of the Murchison River Mine is partly as clean banded ore, which is sometimes well over a foot wide, and part is distributed through the other sulphides.

In the Mackintosh southern section, where J. Geddes is working, the clean ore forms a series of overlapping lenses on the footwall.

The fahl-ore is irregularly distributed through the lodes, even in those where it seems more common.

The copper veins show an even more patchy distribution of the metal through the gangue in the small faces exposed by present workings.

In the North Mt. Farrell Mine, of which the workings are the only considerable ones on the field, there seemed to be no definite pitch of the richer shoots of ore.

There are undoubtedly shoots, for the lode-fracture often is traceable by a seam of pug and the development of siderite on one or both sides in the slate country beyond the point where the galena is present in sufficient amount to be payable.* This is shown by the "No. 1 lode" of the North Mt. Farrell Mine.

Still, the workings are as yet shallow, and more definite information will be available later.

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* "Payable ore" is difficult to define for these mines. It may be reasonably stated to be ore of such grade that from 12 to 15 tons of ore will give 1 ton of galena concentrates, *i.e.*, with a width of lode of from 6 to 8 feet.

The way in which the rich patches of first-class ore cut out abruptly is remarkable in this mine. From visit to visit each face shows considerable changes, both in the total amount of ore and the proportion of firsts.

In my opinion, the presence of the rich bands and pockets of ore is due mainly to the structure of the main and subsidiary fractures in the country rock, and the degree of access to these fractures that has been afforded to the mineralizing solutions.

In the Murchison River Mine this structural peculiarity (referred to above in discussing the influence of country) is so pronounced that the whole of the payable ore is in one great shoot enclosed between porphyroid walls, while the fracture continues beyond on either side. In this case the shoot is pitching southwards at an angle of 55°.

With regard to other variations in the ore, there has already been mention made of the change from a lead to a copper-bearing type along the line of the Mt. Farrell-North Mt. Farrell-Mackintosh fracture. I feel confident that this is one continuous fracture system, that extends right to the Mackintosh River, although its mineral character alters.

Variations of the ore in a vertical direction cannot be said to have been proved by present workings. There is apparently no sign of a progressive impoverishment of the lodes, nor of the galena being replaced by other sulphides. The North Mt. Farrell Mine is again the one from which most information is to be gained; and even here workings are as yet not below the level of the button-grass plain. Still, the lowest workings show no visible falling-off in the amount of first-class ore, even if the assay returns of the firsts average slightly poorer.

The Langdon Mine shows a very abrupt passage of galena into almost pure resin blende in a very short vertical depth, but the workings are very small, and no generalisation could be made applicable to the district from this occurrence alone. Moreover, future operations might reveal at this spot a return of the predominance of lead ores over zinc.

(4)—THE STRUCTURE OF THE LODES.

Fissure Veins.

The majority of the lodes of the Mt. Farrell district are what are commonly known as fissure-veins. The term is used here in a purely general sense. The nature of the filling, whether metalliferous or not, is not implied, nor the manner of the filling, nor the amount of actual filling and the proportion of ore due to metasomatic replacement.

It is merely implied that the veins have, on the whole, a tabular form, and that their present location is governed by the existence of pre-existing fractures, which have served as circulation channels to the ore-bearing solutions. These channels have been chosen by the vein-forming solutions as affording the easiest path to regions of lower pressure.

The fissure veins of Mt. Farrell are in no case single simple ones which fill one clean fracture.

The fracture systems are usually complex, and the ore veins are the same.

There may be a single main fracture with subsidiary ones leading into it at various angles. This is so with regard to the Murchison River Mine and the south workings (J. Geddes' tribute) on the Mackintosh leases.

And the main fracture itself is generally rather complicated, consisting of the actual plane of separation and the crushed zone of country alongside. This crushed zone is usually crumpled and contorted to a high degree, and the metallic minerals, galena and blende, together with the siderite, quartz, and remnants of crushed slate, make up the main bulk of second-class ore.

Slickensiding is usually to be seen on the walls of the main fracture, and indicates a relative movement between the walls in a vertical direction. The main fracture usually has a certain amount of pug.

As regards the origin of the fractures, little information can be ascertained yet. The slate in the neighbourhood is much contorted, and overthrust faults can be seen on a small scale; yet how far compressional forces have contributed to the actual fracturing is hard to say.

The fissures, once formed and filled with ore, have certainly reopened in some places, and the further movements have resulted in the brecciation of the lodes. This lode material of brecciated galena and quartz with pug is well shown on the No. 2 level of the North Mt. Farrell Mine at the extreme north end of the workings, where the soft wet puggy ore runs in on the drive.

The "sheeted zones" or "lode formations" which carry the ore in the Tullah Mine and the Tullibardine are similar, save that the fracture is a distributive one rather than simple. A broad belt of the country suffers simultaneous impregnation.

As to whether the limestone country of the White Hawk district carries any fissures of longitudinal continuity, I was not able to determine at the time of my visit.

The galena in the quartz of the Mt. Farrell Mine forms in a sense a fissure vein of lead ore. It is, however, rather different from the other cases in that there have been two distinct periods of filling. The first period was characterized by an absence of metallic ores, and partial cavities, or "vughs" were left in the quartz then introduced. Some of these cavities, of which the directions and dimensions varied a little, were in continuity with each other. They were also continuously connected with the fractures by which the metallic ores were introduced at a later date; so that, while the lead ores are, in the main, deposited in a separate system of fractures, the older fractures have also served as loci for the deposition.

The ore in the Mt. Farrell Mine has been deposited in the heart of the quartz body. On the southern section of the Mackintosh lease (J. Geddes' tribute) the quartz forms the footwall. The fracture in this latter case has re-opened along the western edge of the quartz, which has adhered to and given stability to the footwall. The subsidiary fractures which lead from the main fracture are all on the hanging-wall (western) side of the lodes.

Disseminated Ores.

The disseminations of copper pyrites and galena show no structural characteristics at all. In one case, near the Osborne Blocks' cage, the joints in the chloritized quartz felsite cut across the ore, and are clearly of later date. The primary ore does not follow any visible divisional plane or cavity in the rock.

(5)—THE STRIKE AND DIP OF THE LODES.

There appear to have been several main directions of fracturing of the crust in the district:—

(1) The main lode-line, which extends from the Mt. Farrell Mine northwards through the North Mt. Farrell and Mackintosh sections, and the Farrell Blocks. The trend of the fracture is, on the whole, a few degrees (9°) east of north; and the dip is between 60° and 70° to the westward.

(2) The Central Farrell and Murchison Extended (North Murchison) Mines are situated on a

fracture system which trends almost due north and south, or a degree or two to the west of north. The dip is west 60°-70°.

(3) The Murchison River lode bears N. 28° E., and thus offers a sharp contrast to the others. It is practically a vertical lode.

(4) On the south side of the river the fractures strike almost invariably west of north. There is little work done, and the figures given must be used with great caution, since they are observations made over very short lengths of lode outcrops, or short development drives. Thomas' Blocks lodes strike about 25° W. of N. The Tullah lode strikes 8° W. of N. at the surface. Foy's lode, near Kittson's, strikes N. 21° W.

(5) The Langdon Mine, to the west of the Tullah town-site, is remarkable in that the lode there strikes due east and west. The dip is to the north.

(6) The northern occurrences at the Tullibardine are very difficult to judge as regards strike, but the prevalent direction of the fractures seems to be east of north about 20°.

With regard to these characters there are a few points of further interest.

The striking feature of the whole system of fracturing is the abrupt change of strike in the case of the Langdon Mine. The existence of an east-and-west fracture in connection with a north-and-south series in this district would not appear remarkable. Here, however, the east-and-west fracture alone appears. There are certainly in the immediate vicinity a few very small fractures running at different angles, but no north-and-south series is visible. The presence of such a fracture system may yet be proved, and its presence seems quite probable from the general structure of the rest of the district.

In the Mt. Farrell Mine the south workings on the western lode show a remarkable series of changes in the strike. From the main adit the lode-channel is driven on for 145 feet on a bearing of 23°. The next 50 feet of driving have a bearing of 9°. Then the lode resumes almost the old course, and is followed for 25 feet on a bearing of N. 25° E. Here a split occurs, and the western drive bears 25° for another 50 feet. The two portions reunite and continue for 100 feet on a bearing of 26°; and then the lode again returns to its former course of 9°, along which 125 feet of driving has been done.

There seems, then, to be two main directions to the course of the lode—9° and 25°; and the reason for this lies probably in the fact that the slate has a distinct "grain." Some part of the break runs with the grain and some portion across it.

(6)—THE ALTERATION OF THE WALL-ROCK OF THE LODES BY MINERAL-BEARING SOLUTIONS.

Coincident with the introduction of the metals into the fractures, and consequent upon the chemical activity of the solutions which have been the carrying agents, there has been usually some marked degree of alteration of the wall-rocks in immediate proximity to the lodes. The change has been caused by the introduction of fresh material from without, or the the partial alteration of the minerals already present in the country rock.

In the North Mt. Farrell Mine the slate, in its least altered form—away from the lodes—is seen to be a pyritic one; yet near the lodes the iron mineral is seen to be the carbonate. Pyrite is to be seen in the lode itself, but the slate seems to have been freed from the sulphur content near the lode fissure.

The iron carbonate may possibly have been all introduced by the lode-forming solution. But if it has, the pyrite has all been removed from the slate. It seems more probable that the iron has been provided by the pyrite, and that siderite is the result of carbonated solutions reacting upon the sulphide.

Besides this alteration there is a notable development of graphite in some places where the lodes occur in the dark-coloured slate.

The graphite may be an original constituent of the slate, but I could not find it in any spot where the lode-forming influences have not been at work; still, in no case did I observe it in any other rock than the dark slate.

The other characteristic alteration effected in the rocks enclosing the lodes is the development of a waxy micaceous aggregate, which has a smooth or even greasy feel in some cases.

This aggregate is perhaps best termed pinite, in that it answers to Dana's* description:—"A general term used to include a large number of alteration products, especially of iolite; also spodumene, nephelite, scapolite, felspar, and other minerals. In composition, essentially a hydrous silicate of aluminium and potassium, corresponding more or less closely to muscovite, of which it is probably to be regarded as a massive, compact variety, usually very impure from the admixture of clay and other substances."

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* "A Text-book of Mineralogy." Edition 1899, p. 466.

The dark-coloured slates are not visibly altered in this way. No microscopic examination has been made to find whether the alteration has been effected, even though not visible to the naked eye.

In the pale-coloured clay schists, however, the change is well defined. The rock already contains a considerable amount of sericite,† but this is materially augmented, and a yellow to green waxy product results.

This is to be seen on the Mackintosh and Farrell Blocks sections, as well as with both the lead and copper veins of the Tullibardine; in fact, wherever the lodes traverse this clay schist.

The porphyroid suffers an entirely similar alteration, and the spathic type of lode is accompanied by a greater degree of change than is the pyritic.

The country of the Thomas' Blocks main lode is this porphyroid which has been strongly attacked in this way.

In this section the rock still shows the idiomorphic and embayed quartz phenocrysts, but almost the whole of the rest of the rock has been replaced by the pinitic aggregate.

The same is true to a less degree of the country rock enclosed in the lode-formation of the Tullah Mine.

This is the type of alteration which has been termed "sericitization."

Yet another alteration has taken place in the case of the disseminations of lead and copper ore on the Osborne Blocks.

Here a silicification of the chloritized quartz felsites is the characteristic accompaniment of the ores. The silica has proceeded into the quartz felsite, and filled up the minute cracks, and has bodily displaced the igneous rock as well. The invasion of quartz is gradual, and there are no clearly defined lines between the unaltered and altered quartz felsites.

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† *Vide supra*, p. 22.

(7)—THE SECONDARY ALTERATION OF THE LODES.

One of the striking features of the Mt. Farrell field is the small amount of oxidised ore that has been formed by the action of the meteoric water upon the lodes.

The outcrops, where they are visible, are covered with a very thin rusty coat, which shows a little—very little—lead sulphate or carbonate.

As a rule, the outcrops are only laid bare in the stream beds. On the other portions of the hill-slopes the soil-creep brings a cover of the country rock from higher up the slope, till the lode outcrop is completely hidden.

So any oxidised crust that could form would tend to join the surface material on its downhill path, and the conditions necessary for the accumulation of a gossan have not existed since the present physiographic cycle began.

A few ironstained lumps of ore with a core of galena can be still picked up in the creek beds, but no gossans are to be found of any value or extent. Even the pyritic mass of the Murchison River Mine has a very small capping of gossan.

Lead carbonate is practically not to be seen. There are a few crystals on the Murchison Mine in the ironstone near the surface. I saw a little on the surface of the North Mt. Farrell and Mt. Farrell Mines. The White Hawk Mine contains a little more; but there the country rock is limestone and far more permeable by surface-waters.

In no case was there visible any silver chloride or other secondary silver ores.

The quartz reef of the Mt. Farrell Mine containing the vughs filled with lead ore has arrested the downhill creep of the ore, and the result is that secondary processes have there been operative. The unfilled vughs have assisted by enabling an active circulation of surface waters to attack the upper portions of the deposit. Some of the contents of this upper portion have been leached out, carried downwards, and redeposited at lower levels. The lead is redeposited in the form of octahedral crystals of galena, whereas the first-formed ore is invariably cubic in form.

The octahedral galena is found either deposited upon the cubical metal in the heart of vughs, or embedded as fairly-perfect crystals in a greenish kaolin occurring in pockets along the borders of the primary fillings of the vughs. A similar deposition of secondary octahedral galena upon the primary cubical mineral is mentioned by

Van Hise as occurring in the lead deposits of the Mississippi valley.*

But for this case, the lead ores of the field show no sign that can be taken as undoubted evidence of secondary concentration.

The existence of rich shoots of secondary ore has not been proved; and this point is one of great commercial interest. It is frequently stated on the field that the mining operations are as yet "too shallow." The apparent inference is that deeper workings will lay bare richer ore; but such richer ore is only to be confidently expected when a zone of leached ore has been passed through in the upper workings.

The bulk of the lead ore at Mt. Farrell is, even at the surface, practically fresh and undecomposed, and, with the single exception indicated, free from leaching, and not enriched by secondary processes. Still, this fact carries much comfort to mines like the North Mt. Farrell, whose first-class ore can be therefore confidently expected to descend. It is not the result of a local concentration, nor due to the formation of a zone of secondary enrichment that might be expected to give place to poorer ore with deeper development.

The copper deposit on the Tullibardine lease has suffered some degree of alteration, and the copper that has been leached out of the upper portions of the lode has been redeposited, in part at least, in the form of native copper.

This native copper is in a very fine state of division, and is distributed through the ironstained clay schist between the seams of cupriferous quartz.

Its quantity will probably not prove to be considerable. The zone that has, by the leaching processes, provided the native copper is not more than a few feet in depth; and the total bulk of copper ore in the formation cannot be expected to produce much secondary ore.

(8)—THE UNDERGROUND WATERS.

Before venturing to formulate an account of the mode of origin of the lodes of Mt. Farrell, it will be well to consider the phenomena now presented by the underground waters. For the ores have been undoubtedly deposited from solution, and the origin of the ores is involved with the origin of the solutions which brought them to their present position.

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* Van Hise: "A Treatise on Metamorphism," pp. 1145 and 1146.

When the rainfall at Mt. Farrell is taken into consideration the underground workings appear to be remarkably dry. The water that is met with is restricted to the planes of movement of the rocks, and the rock-masses between these fracture-planes are dry.

In the North Mt. Farrell Mine practically the only water that finds its way into the workings is to be seen where the clay schist is in contact with the dark slate.

The lodes are always damper than the country rock. For instance, the Mt. Farrell south workings on the western lode show a good deal of water, and the neighbouring crosscut in country rock is nearly dry throughout.

Moreover, the water makes its way downwards in every case which I observed, with the exception of an occurrence in the Mt. Farrell Mine. This is in the quartz body which contains a number of vughs, as already explained. The main adit on the northern workings has cut across the quartz reef, and a bubbling spring of water appears in the sole of the drive. This spring is directly below the main line of ore-filled vughs mentioned above. But the spring-water is fresh and cold, and is clearly the surface-water that has an intake at some point higher up the hill. The exact channel by which it has travelled is not visible; yet there, is probably a main cross-fracture dipping west and connecting in depth with the cavity in the quartz by which the water ascends.

The circulation at this point appears to be free, and the flow considerable; yet it must be remembered that this freedom of circulation was impossible until mining operations penetrated the fractures at a level below their intake. Before mining began the natural circulation must have been very much more restricted.

Even now there are cases that show how "tight" the lodes are. The Mt. Farrell northern workings contain a shaft beneath which a drive on the lode has been put in; and during my visit to the field, lasting over nine weeks, the water had not drained out of the shaft.

It is stated on the field that the amount of water that drains away from the mines does not vary much with the seasonal changes. My visit to the field was too brief to judge this matter by personal observation.

There is no evidence at Mt. Farrell at present available to show the existence of any other water in the mines than that which has fallen on the surface as rain, and which has made its way downwards under the influence of gravity alone. Yet it cannot be granted that this surface-water can have been the agent whereby the lode-matter has been introduced into the fractures.

For the alterations that have been effected in the wall-rocks, as well as the insolubility of the lode-forming minerals in pure and cold water, lead us to believe that the solutions which produced the lodes were hot, and that they contained salts in solution; and further, that these solutions ascended from deeper portions of the crust by paths of considerable downward continuity. These circulation-channels which offered the least resistance to the ascending mineral waters were the main fracture planes of the district.

The surface-waters have had very little to do with the lodes. Their effect in modifying the mineral composition of the lodes which the ascending waters have deposited has been dealt with under the head of the secondary alteration.

The unoxidised ore being found almost at the surface, it is not remarkable that no line can be drawn to show the "ground-water level." This line, which marks the level below which any excavation remains permanently full of water, may be said to almost coincide with the ground-surface in most portions of the field.

In the White Hawk limestone it is naturally at a lower level, but how far down below the adit level it exists was not determined when I visited the property.

(9)—SUMMARY OF THE GENESIS OF THE LODES.

As the result of the consideration of the facts dealing with the Mt. Farrell district which have been gathered together, and the comparison of these facts with those now known concerning other mining fields, a brief outline may be formulated of the most probable origin of the lodes. The views of the writer on this subject must be held to be neither original nor unusual. An attempt is made here to apply to the Mt. Farrell field the results of conclusions arrived at by many mining geologists, especially in America and Germany, concerning the origin of ore deposits.

First of all it becomes apparent from what has been said above concerning the independence of country and lode, that the proximate source of the ores must be sought outside the rocks in which they now occur.

The question arises then, "To what portion of the earth are we to look to discover their origin?" And in answer to this question it should first be stated that metallic ores which are the fillings of cavities or fractures in rocks at a date subsequent to the formation of the rocks themselves (*i.e.*, the so-called *epigenetic* ore deposits) have almost invariably been introduced from below.

Looking downwards, we are at a loss to see any rock-mass which differs from that which contains the lodes on the surface, for the development of the mines in depth can hardly be said to have been started yet.

Here the geological structure observed is of assistance. The only rock-mass which can be considered to underlie the rocks of the field in depth is the granite which outcrops at Granite Tor, and appears there to be dipping below the mantle of mica schist towards the west.

The majority of mining geologists are of the opinion that the ore deposits of deep-seated origin derive their metallic contents from plutonic igneous magmas, and that granitic magmas especially are the proximate sources of the metallic minerals. The granitic magmas during their solidification, give off a quantity of mineralized vapours and solutions, which ascend by the most accessible channels, and deposit their metallic contents during the ascent.

We know that there is a very large area of Western Tasmania underlaid by a granite mass, which at its outcrops at Hampshire Hills, Middlesex, Cox's Bight, and Heemskirk is stanniferous.

The country overlying this granite is mineralized in many places, for it is a much-folded, and therefore much-fractured area; and some of the minerals found with other ores show characters which help to connect them genetically with the tin ores. Such minerals are those which contain boron and fluorine.

The discovery of fluorspar at Thomas' Blocks is of great importance in this search for the origin of the Mt. Farrell lodes, for fluorspar is a mineral most characteristic of the lodes, either in granite or in immediate proximity to granitic masses. It is, for instance, a common gangue mineral in the Middlesex tin-wolfram deposits, and on the north-east tin-fields is common near the lodes.

The only other mineral which occurs at Mt. Farrell, and which is a common associate of the typical ore-veins of granitic areas, is native bismuth, which is quite plentiful at Kittson's workings in the south-eastern portion of the field. So we may reasonably infer that Mt. Farrell owes its mineral impregnation to the granite which outcrops at the places mentioned.

The agent by which the metallic contents of the lodes were borne to their present position was undoubtedly, in the main, water; but the solutions rising up the lode-fissures were probably of complex composition, and, like the waters of the hot springs of to-day, they probably contained sulphur in the form of sulphides or sulphates of various elements, together with carbonic acid, free and combined. Such heated rising solutions would cause the alterations of the wall-rocks that have been mentioned.

The confinement of these ascending solutions to the main deep fracture-planes is explained by the fact of their deep-seated origin. The deeper fractures would be the ones which would offer paths of less resistance to the imprisoned vapours.

Once formed, the lodes have shared in the general degradation of the region by surface agencies. They have been attacked to some extent by the processes of oxidation, but the accumulation of the oxidized material has been prevented by the physiography of the lode-bearing zone.

VI.—THE MINING PROPERTIES.

(1)—The North Mount Farrell Mining Company, No Liability.

The sections held by the company are the following:—4116-93m, 68 acres; 2722-m, 40 acres; 1074-m, 20 acres; 3262-93m, 76 acres; 1867-m, 80 acres; 2351-m, 75 acres; 292-w, 10 acres; and 82-w, 4 acres.

Of these sections, that which is numbered 3262-93m is much the most important, and carries the principal workings and the concentrating mill.

From the accompanying geological map it will be seen that the lodes worked by this company are situated on the western side of the slate belt, and close to the narrow band of pale clay schist.

There are four main levels at which work has been carried out. These are named respectively No. 1, No. 2, No. 3, and No. 4, and are separated by vertical distances of about 60 feet. The workings have disclosed the presence of three main lodes, which converge towards a point situate in the neighbourhood of the open-cut.*

Of these lodes, the eastern one, called by the management the No. 3 lode, seems to be undoubtedly the principal one. It conforms, on the whole, to the general direction of strike of the fracture which runs southwards through the

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* See plan of mine workings, Plate IV.

Mt. Farrell ground and northwards to the Mackintosh River. Its continuity is much more pronounced than the other two, and the distribution of ore more uniform. The other two lodes are nevertheless valuable assets, for although the present output is being maintained mainly by the No. 3 lode, the No. 1 and No. 2 lodes will almost certainly provide much ore with deeper development.

The No. 1 lode, situated almost on the edge of the main body of slate, and in immediate proximity to the clay schist, strikes about N. 35° E., and dips westwards at about 60°. It is a very broad lens of ore, which was first encountered in driving the No. 4 level crosscut.

On development it was found not to extend upwards very much above the No. 3 level, where it splits into two bodies separated by mullock.

All the ore has been stoped out of this lode above the No. 4 level, with the exception of a small pillar above this drive.

There has beeen a large body of ore removed, as the total length of this ore lens is, on the No. 4 level, 240 feet, and it has been stoped out for a width of 35 feet in places.

All of this ore having been removed, I was unable at the time of my visit to inspect and note its characters.

There have been drives put in northward on the line of this lode, which is marked out by a slight development of the carbonate of iron in the country rock; but on both levels a blank of about 120 feet was met with.

A crosscut driven west on the No. 3 level, at a point a little south of the intersection of this barren channel with the No. 2 lode, met with an ore-body, which is now being prospected. Assay returns, showing 82 per cent. of lead and 60 ozs. of silver per ton, have been obtained from the galena at this point.

This body is now being prospected northwards on the No. 4 level, and a lode 4 feet wide has been proved. A little first-class ore is showing, and the footwall is deeply slickensided. On the No. 3 level the grooving of the wall-rock was noticeable on the hanging-wall side of the lode, and no defined footwall was visible.

A short crosscut was put in to the westward on the No. 4 level to test the width of the formation. Some galena was met with, but no defined wall. Work is proceeding along the line of the lode.

It may be that this ore-body is a continuation of the No. 1 lode, but it seems more likely to be a separate branch lode from which some ore has been won at the surface a little further northwards on the No. 2 level.

The only other work done upon the western ore-channels is a winze sunk from the No. 4 level on the No. 1 lode. It has been sunk some 30 feet, but was full of water at the time of my visit.

I am informed that the ore on the No. 4 level for the whole length of the ore-shoot was of good quality; and there seems to be every reasonable prospect that deeper workings will expose a continuation of these values in depth.

The No. 2 lode has a strike about N. 17° E., and the westward dip is steeper than that of the other lodes. This lode has been productive of ore, especially above the No. 2 level, whence stopes have been carried to the surface for 750 feet in length. Recently the track of the ore-channel has been driven on at the No. 1 level, and the strike changes through a wide angle rather abruptly. The fissure seems to be making towards the No. 3 lode-channel as if it would unite with it.

Between the Nos. 2 and 3 levels this central ore-body has been productive for about 400 feet, for which length stopes have been carried for nearly the whole height. Between levels No. 4 and No. 3 there are stopes for a length of 250 feet, but the southern extension of the lode-channel shows ore of poorer grade.

On the No. 4 level the same abrupt change of strike is noticeable as on the No. 1, and there seems no doubt that this ore-channel will join that of the No. 3 lode if traced out in future workings.

The No. 3 lode is the principal source of the ore which is being won at the present time. It is a lode from 15 to 22 feet in width, and a brecciated zone about 6 feet wide on the footwall side.

No hanging-wall at all is to be seen. The boundary of the lode on that side is arbitrarily fixed by the grade of the ore. There seems to be a definite footwall with a seam of pug, but ore is often obtained beyond this wall.

The pug sometimes carries ore, a fact which seems to indicate later movement in the lode-channel. The veinlets of metal in the main body of ore are irregularly disttributed; but the larger seams of firsts run with the direction of the channel.

The strike varies in the portion developed from a few degrees west of north to about the same amount east of north.

The dip is between 60° and 70° to the westward.

In developing this lode the prospecting drives have been pushed forward in the brecciated zone on the footwall, and have been timbered. The ore is broken out from the lode later, and this ground needs very little timbering.

From this No. 3 lode there still remains much ore to be won from that portion which is already being worked.

On the No. 4 level it has been stoped out for 120 feet south of the main crosscut to a height of 15 feet. Then, on the northern side of the crosscut, there are about 540 feet of stopes from which 18 feet of ore have been removed.

On the No. 3 level there is not so much work done at the southern end. At a point 30 feet north of the rise which runs from the No. 4 to the No. 2 level the stopes begin, and reach a height of 30 feet at a distance of 180 feet from the rise. In the next 180 feet their height rises to 50 feet, and continues at that level above the drive for another 75 feet, where the rise is taken from No. 3 level up to the open-cut. North of this point there is hardly anything more than development work done.

Vertically above these stopes last mentioned (with a vertical height of 50 feet from the level) there is a block stoped out to within a few feet of the open-cut from the No. 2 level, but no further stoping is done on this level. The ore above the drive is practically unknown, and trenches are being put in on the surface to endeavour to locate the outcrop. Since my departure from the field it has been reported that the lode has been picked up.

At its northern end this lode encounters the quartz, which appears to pitch S.S.W. from its outcrop in the open-cut. Beyond this it has not been followed on the No. 4 level, but a drive has been continued northwards past the quartz on the No. 3 and No. 2 levels.

The ore-body changes in character after traversing the silicified zone, and consists mainly of a wet running pug charged with brecciated fragments of quartz, galena, and slate. This is especially noticeable on the No. 2 level, where the ore-body has run in on the drive. This ore resembles that which is worked about 150 feet further north, in the Mackintosh section. The galena is said to be finer in the North Mt. Farrell workings, but the ore does not appear different in general character.

At the south end of the present workings on this lode there is a silicified zone of the slate met with, and the lode seems much disturbed and poor. Still, the channel of the circulation is there, and the development of this end of the property should reasonably prove further payable ore in this direction. The grade of the ore cannot be expected to remain quite uniform throughout, and it should be remembered that during the earlier days of the mine this No. 3 lode was passed through in a crosscut which penetrated into the country 35 feet beyond the lode, and the presence of the lode was not detected.

At the present time the No. 4 level crosscut is being driven eastwards, and has attained a total length of 900 feet from the mouth of the adit. It is being driven in the hope of meeting with further lodes to the east of the present system.

The grounds for supposing that any ore-bodies occur on the property in such a position that they might be cut by this tunnel seem to me insufficient. The occurrence of lead ore in the quartz reef on the Mt. Farrell Mine is one possessing many singular features, and it would apparently be remarkable indeed if the North Mt. Farrell Mine met with any similar body of ore. As indicated above, and referred to again below, the existence of the vughs filled with ore requires a very exceptional chain of circumstances, and the existence of a separate lode system of any magnitude further to the east is not yet proved.

There is, it is true, a small veinlet of ore on the south-eastern boundary of the open-cut; but I regard this as purely a subsidiary fracture, and not likely to possess any great horizontal extent.

The quartz masses in the slate have been shown to be of separate origin from the lead ores, and the quartz reef on the Mt. Farrell property bends sharply to the north-east, and then disappears on entering the North Mt. Farrell lease. There are other quartz outcrops further north, but while of similar origin to the main masses, their continuity with these is doubtful.

The North Mt. Farrell output is largely made up from their second-class ore. The proportion of first-class ore to seconds is shown in the table below. The concentrating mill has lately been enlarged, and it is estimated that it is now capable of treating from 65 to 70 tons of ore per shift of eight hours.

Mill Scheme.—From the bins the ore goes to the jaw-crusher, which reduces it to a size of 1 or 1¼ inch. Thence it passes to trommels, which separate the fines. The latter go straight to the tables, and the coarse material passes to two topping jigs.

Thence the ore passes to the coarse rolls, which crush it to ⅜-inch, and deliver it to the first sizing trommel. The oversize passes to the second rolls, and the remainder is elevated to the jig-trommels.

There are four screens, whose apertures are as follows:—$\frac{1}{4}$-inch circular, $\frac{3}{16}$-inch circular, $\frac{3}{32}$-inch circular, and $\frac{3}{8} \times \frac{1}{32}$-inch slots. These screens control the supply to the first four jigs; and the fines which pass through the last screen go to the tables.

The middle products of the jigs go to the second rolls.

These second rolls feed the sizing-trommel on the other side of the mill. The oversize (above $\frac{3}{8}$-inch) is returned by an elevator to the rolls. The remainder of the ore passes to the jig-trommels. There are four jigs on this side also, and the material they treat is sized by screens with the same apertures as on the other side of the mill. The fines pass to the tables. The middle products of these jigs go to the dump.

The tables include two Cards, one Wilfley, and one Sperry.

In addition, it is proposed to put in a regrinding plant to deal with the middle products from the tables and second jigs. This addition will undoubtedly greatly improve the efficiency of the mill.

The value of the mine and mill products may be seen from these figures, which are the averages of the assays between the months of July and October, 1907.

	Lead. per cent.	Silver (ozs.) per ton.
No. 3 tunnel, firsts	62·3	64·9
No. 4 tunnel, firsts	58·9	62·8
Jigs	51·1	47·9
Slimes	55·2	44·9

THE NORTH MT. FARRELL MINING CO., NO LIABILITY.

Comparative Statement, showing Average Results for the Last Seven Half-years.

	October 31, 1904.	April 30, 1905.	October 31, 1905.	April 30, 1906.
Crude ore, total quantity handled	6356·77 tons	6237·13 tons	7838·95 tons	10,294·92 tons
Crude ore, quantity handled for each ton of marketable ore produced	7·24 tons	7·70 tons	9·66 tons	8·75 tons
Crude ore, silver recovered, per ton	9·45 ozs.	9·61 ozs.	6·39 ozs.	6·02 ozs.
Crude ore, lead recovered	8·40 per cent.	8·50 per cent.	6·15 per cent.	6·17 per cent.
Marketable ore, quantity produced	876·79 tons	809·52 tons	811·28 tons	1175·5 tons
Marketable ore, total value at mine	£7393 3s. 5d.	£8905 15s. 3d.	£7371 10s. 0d.	£11,508 1s. 9d.
Marketable ore, net value per ton at mine	£8 6s. 4d.	£11 0s. 0d.	£9 1s. 8d.	£9 15s. 9d.
Marketable ore, average silver assay	68·42 ozs.	74·10 ozs.	61·82 ozs.	52·87 ozs.
Marketable ore, average lead assay	60·83 per cent.	65·51 per cent.	59·51 per cent.	54·07 per cent.

	October 31, 1906.	April 30, 1907.	October 31, 1907.	—
Crude ore, total quantity handled	12,091·53 tons	12,282·05 tons	13,506·1 tons	—
Crude ore, quantity handled for each ton of marketable ore produced	8·51 tons	8·1 tons	7·6 tons	—
Crude ore, silver recovered, per ton	6·19 ozs.	6·33 ozs.	6·91 ozs.	—
Crude ore, lead recovered	6·71 per cent.	6·54 per cent.	7·36 per cent.	—
Marketable ore, quantity produced	1420·68 tons	1501·6 tons	1778·91 tons	—
Marketable ore, total value at mine	£15,872 12s. 10d.	£17,574 9s. 4d.	£21,505 11s. 10d.	—
Marketable ore, net value per ton at mine	£11 3s. 5d.	£11 14s. 0·7d.	£12 1s. 9·4d.	—
Marketable ore, average silver assay	52·69 ozs.	51·1 ozs.	52·47 ozs.	—
Marketable ore, average lead assay	57·16 per cent.	53·53 per cent.	55·91 per cent.	—

(2)—THE MT. FARRELL MINING COMPANY, NO LIABILITY.

This company holds the following sections:—2409-93M, 80 acres; 2410-M, 80 acres; 2656-M, 10 acres. The main workings are situated on Section 2409, and are situated on the northern and southern boundaries of the section.

There is one well-defined lead-bearing lode on the property, and this is, in my opinion, undoubtedly that which continues northward through the North Mt. Farrell and Mackintosh leases. On this property it is referred to by the management as the "western lode." A considerable quantity of ore has been recovered from the occurrence in the strong quartz reef, which is a filling of a line of vughs with lead ore, and at both the northern and southern workings on the Section 2409 the quartz mass has been prospected.

The Northern Workings.—The main adit starts from the northern boundary, and runs in some 725 feet on a bearing of 109°. It is situated 180 feet above the No. 4 tunnel of the North Mt. Farrell Mine.

The tunnel was started in massive porphyroid, and continued in this for 289 feet. Then followed 49 feet of pale clay schist; and then 225 feet of slate were passed through before the "western lode" was met with.

This lode was driven on northwards for 23 feet. It shows quartz and siderite, and carries some milling ore here and there over a width of 3 feet.

Southwards the lode has been driven on for 175 feet, and in the last few feet a deviation to the east was made to carry the workings under a shaft formerly put down on the surface. Some 20 feet back from the face of this drive, the workings were again carried southwards for 53 feet on the lode. The lode contains from 2 to 3 feet of milling ore, in which bunches of firsts are to be found. There is a well-defined footwall on this lode, which dips to the west at 60°. The hanging-wall was good up to the point where the drive deviated to the east. As in the case of the North Mt. Farrell No. 3 lode, the footwall country here sometimes carries ore behind an apparently sharply defined wall.

The strike of the lode here is between 22° and 25° east of north. As mentioned above, the lode-fissure has two prominent directions of strike in this section, viz., 9° and 25° east of north; and the northern workings conform to the latter direction.

On driving the main crosscut another 88 feet eastwards a big quartz formation with a total width of 50 feet was met with. It dips west at 70°. The hanging-wall is well defined, and the quartz is massive on this side; but on the footwall side there are numerous vughs and fragments of undigested slate in this quartz.

A drive has been carried southwards along the hanging-wall of the quartz on a bearing of 185° for a distance of 159 feet. A little galena was visible now and then at the junction of quartz and slate.

When the main crosscut had been driven 44 feet past the hanging-wall of the quartz body some second-class lead ore was met with. The crosscut was continued another 30 feet, and finally abandoned in a dense pyritic slate like that intersected by the No. 4 level crosscut of the North Mt. Farrell Mine east of the lodes.

From the point where the second-class ore—siderite and galena—was met with, a rise was put up. For the first 16 feet only payable seconds were met with, but these gave place then to clean first-class ore, which continued to within 10 feet of the surface. This remarkable ore-body turned out to be due to the filling of a long line of vughs in the quartz with lead ore. The ore is entirely surrounded by quartz, and the central cavity of the vughs was not completely filled with ore.

The vughs pitch in all directions, and the ore-channel has a most irregular form. The ore from this pipe carries a little carbonate of iron and a compact green mineral, which I take to be a mixture of sericite and kaolin. Octahedral (rarely with dodecahedral modifications) galena occurs on the outer surfaces of the mineral crust, having apparently been deposited on the cubical galena by secondary processes. It also occurs in very perfect crystals in the soft pug and brecciated quartz sometimes found on the borders of the vughs. The whole of the ore at this place shows a brownish stain from the presence of limonite.

At the top end there is some zinc blende with the siderite and green sericite-kaolin aggregate. Most of the ore had been removed from this rise at the time of my visit. A little remained on the level on the north side of the main crosscut in a mixed gangue of quartz and carbonate of iron. There is a spring of water bubbling up on the level from below at this point.

From the south drive on the hanging-wall of the big quartz formation, at a distance of 68 feet from the main adit, an eastern crosscut was driven through the quartz for 46 feet. An empty vugh was passed through at 21 feet. At 40 feet a body of quartz and siderite was met with, and a rise was put up on it for 69 feet. At the lower end of the rise very little metal was showing, but at the top good seconds were found. The rise was abandoned at 69 feet from the level on account of bad air. A candle would only just keep alight at the time of my visit. This rise was later connected with the upper workings by sinking from the intermediate level.

At a distance of 100 feet from the crosscut just mentioned another eastern crosscut was started from the south drive. It was in some 37 feet at the time of my visit, and was in a silicified zone of slate carrying clean quartz veins.

On the surface above these workings some considerable prospecting has been done. An open-cut 12 feet deep and 18 feet wide has been broken out at a point 40 feet south of the first rise. Veins of clean ore occur in the quartz at this place, and some firsts have been bagged. To prove the occurrence an adit was driven 30 feet lower down, and met with the ore distributed irregularly through the quartz; and 8 tons of firsts were recovered in the work.

Some 15 feet below these workings a short intermediate level has been driven, and good ore proved. These workings are 85 feet above the lower level.

In prospecting the good second-class ore south of the first rise a fresh body of firsts was met with similar to that in the first rise. The work done on this has resulted in the proof of the continuation in depth of this ore to the second rise put up from the lower level. The upper workings are now connected with the lower by this rise also.

This occurrence of ore has been mentioned in an earlier part of this report. It seems to me to be undoubtedly due to the passage upwards of mineral-bearing solutions through long lines of connected vughs in the quartz. The two rises are similar in general structure, but the No. 1 rise carried much more first-class ore. At the intermediate level the ore seems to have been more scattered through the quartz. There appears to be, on the evidence of the two rises, a shoot of first-class ore pitching north at a steep angle.

There is nothing to show the existence of another line of ore-filled vughs, and the present system of prospecting (from the lower level south drive by crosscuts across the quartz body) does not appear to me to be either the least expensive or the most likely to prove the existence of other pipes. I should recommend that the prospecting in a southward direction for the ore contained in the quartz be continued on the intermediate level, where the track of the ore is better defined. Any apparent downward continuation of ore could then be prospected at a lower level without the uncertainty which exists at present.

At the lower level I should recommend that the prospecting work be done by driving on the line of the two rises already located, rather than by crosscutting from the drive on the hanging-wall of the quartz-mass. This latter method is nothing more than blind stabbing, and the small horizontal extent of the pipes makes it a very easy matter to miss the ore when within even a few inches of it.

The question of prospecting northwards on this level is worth considering carefully. The ore-shoot appears to pitch in that direction, and the northern boundary of the section is about 400 feet distant.

A shaft was sunk at the outcrop of the western lode for a depth of 50 feet, and abandoned. It contained water at the time of my visit, but was being gradually drained by the south drive on the western lode below it.

At the surface there is some good milling ore, said to be from this shaft, but I could not see the ore *in situ*.

The Southern Workings.—The upper adit level has been put in for a distance of 236 feet on a bearing of 107°. At 207 feet from the entrance a short drive has been put in northwards for 51 feet bearing 21°, and a crosscut driven westwards for 21 feet on a body of second-class ore. The main workings on this level are 29 feet further east, where a drive runs north for 102 feet on a bearing 25°. A rise has been put up for a few feet on ore, and a couple of narrow stopes 3 feet wide taken out. I saw a couple of inches of firsts on the footwall here.

No work was being done on this level at the time of my visit.

The main adit is driven on a bearing of 57° for a total distance of 342 feet. A short drive has been carried northward (bearing 14°) from the end for 25 feet. No ore was met with in this end of the adit. At a point 263 feet from the mouth of the adit the "western lode" was driven on. For 145 feet the bearing is 23°, then for 50 feet it is 9°. At this point a crosscut was driven eastwards.

Beyond the crosscut the course of the western lode is N. 25° E., and at 25 feet past the crosscut the lode splits with a "horse" of slate between the two portions.

The western drive of the two runs on for 50 feet past the split on a bearing of 25°. Here there is a rise, which has been put up for 40 feet, and two stopes have been taken out for a distance of 60 feet on fair milling ore.

Then the two arms of the lode rejoin, and the lode is followed for another 100 feet on a bearing of 26°. The course then returns to 9°, and the face at the time of my visit was 125 feet from the bend.

Taken all through its length, the western lode represents about 3 feet of milling ore, and the lode-channel is well defined always.

It is to this ore-body that the company must look for the main bulk of the milling ore of the future. There may be other more concentrated bodies of ore discovered in the quartz reef, but their presence is so far unproved.

Further prospecting of the quartz has been done on this level. At a point 196 feet from the main adit on the western lode drive a long crosscut has been put in eastwards for a total length of 334 feet on a bearing of 105°. At 217 feet the quartz body was met with. At 264 feet a few splashes of galena were met with, and short drives were put in for 25 feet northwards and 15 feet southwards on a bearing of N. 15° W. The metal cut out, and work was abandoned.

At 287 feet on the eastern boundary of the quartz another short drive was started northwards, but abandoned after being carried for 10 feet.

The eastern crosscut was continued for 50 feet past the quartz, and abandoned in dense pyritic slate.

The prospecting was continued on this level from a point 15 feet west of the hanging-wall of the quartz, and 202 feet from the western lode drive. There a drive has been carried northwards for 100 feet on a bearing of 2°, and from that point the drive turns to the east to cut the quartz body. Occasional splashes of galena are to be seen in the quartz here, but always associated with siderite.

The milling ore from the mine is stacked separately on the tip to provide a nucleus for future milling operations.

A little work has been done below these main southern workings on the northern boundary of Section 2410, but nothing more than slate carrying carbonate of iron is visible. At a point 30 feet from the south-west corner of the northern section, and on the line between the two sections a tunnel was started to test the western portion of the property. It runs for 80 feet on a bearing of 66°, but only chloritised porphyroid, in which some hard silicified zones were found, was penetrated. Some quartz and iron carbonate were visible, but no ore. The tunnel is now used as a magazine.

On the southern section a little surface-trenching has been done at two other spots. On the eastern boundary a little galena is visible in the creek, which crosses the line in several places. This spot is very close to the line of the lodes met with in the Central Farrell property, and the ore-channel may be connected with that fracture system.

Further south a trench 2 chains long has intersected an indefinite formation. The trenches are narrow and shallow, and consequently do not afford much information. There is a certain amount of gossan carrying pockets of carbonate of lime, and in this gangue a few splashes of fahl-ore and copper pyrites are visible. The country rock, to judge from the weathered material intersected by the trench, is slate.

Appended is a table which will give an idea of the grade of ore from this mine. It has been compiled from the sale notes of the company.

SALE NOTES OF ORE FROM THE MT. FARRELL MINE.

Date.	Net Weight.			Assay Value.		Total Value per Ton.			Metal Quotations.			
				Lead.	Silver. (oz.)				Lead (per Ton).			Silver (per oz.).
	tons.	cwt.	qrs.	per cent	per ton.	£	s.	d.	£	s.	d.	d.
Nov. 27, 1906	6	15	3	71·8	91·9	27	8	7	19	5	0	35·54
Jan. 7, 1907	31	19	0	69·6	94·6	27	11	10	19	18	9	34·80
Feb. 8, 1907	22	10	1	67·5	91·0	26	2	5	19	13	9	33·85
May 3, 1907	16	12	1	70·0	92·7	26	18	2	20	5	0	32·97
May 3, 1907	17	19	3	69·1	97·6	27	8	0	20	5	0	32·97
May 27, 1907	12	4	1	65·0	90·5	25	3	11	19	15	0	32·77
June 7, 1907	14	12	3	67·5	90·0	26	6	4	20	7	6	33·50
July 17, 1907	8	16	0	60·4	80·0	23	5	1	20	2	6	33·30
July 17, 1907	8	17	3	56·2	74·0	21	17	1	20	10	0	33·51
July 22, 1907	8	19	3	56·4	76·9	17	18	8	20	12	6	33·71
Aug. 28, 1907	19	12	2	54·4	72·2	16	6	10	19	12	6	33·70
Oct. 31, 1907	13	13	3	67·9	97·1	21	16	4	20	1	3	31·82
Oct. 31, 1907	7	11	1	66·4	92·3	19	5	3	18	5	0	30·28
Dec. 13, 1907	5	4	3	57·0	72·1	17	12	11	15	15	0	28·85
Jan. 16, 1908	5	6	2	53·2	74·6	16	7	9	14	11	3	27·80

(3)—THE MURCHISON RIVER SILVER AND LEAD COMPANY, NO LIABILITY.

The company's leases are the sections thus numbered:— 3263-93M, 60 acres; 1980-M, 80 acres; and 1286-M, 5 acres. The latter is the mill site.

Of the two sections on which mining operations are carried on, that numbered 3263 carries the principal workings.

The lode which has been exploited on this section has a strike of N. 28° E., and is very nearly vertical, dipping if anything to the east; so its structure is quite distinct from that of any other of the lodes of the field thus far exploited.

The lode-fissure traverses obliquely a belt of porphyroid, which is at this point 70 feet wide, and strikes due north. On either side of the porphyroid is slate, and the dip of the igneous belt is about 70° to the west. The productive portion of the lode-fissure is that which is enclosed within the walls of porphyroid. The lode-channel extends into the slate at both ends, but little has been done to prospect these northern and southern continuations.

The lode has been worked by means of an open-cut and two high-level adits near the outcrop, and one low-level adit which starts almost on the level of the button-grass plain and intersects the lode some 87 feet below the level above.

At the time of my visit the mine was inactive, pending the reconstruction of the company.

The recent work has been restricted to the open-cut and the block of ore between the No. 3 and No. 2 levels.

Above the No. 2 level almost all the ore has been stoped out.

No. 1 *Level.*—The adit at this level was driven eastwards on a bearing of 279°, and was continued right through the main lode into the country beyond.

The main lode matter has now been removed. Further to the east there were two minor veins of ore from which a little mixed blende and galena have been obtained. These are apparently branches of the main lode, and their dip is towards the latter.

No. 2 *Level.*—The adit was driven on a bearing of 277°, and 40 feet below the upper one. The ore above this level has been almost wholly stoped out.

No. 3 *Level.*—The main crosscut was driven eastwards on a bearing of 260°. Its total length is 513 feet, of which the first 450 feet were in slate and the last 63 in the porphyroid. At this point the lode was cut, near the northern extremity of the shoot. A drive has been carried both north and south on the ore-channel.

At a point 27 feet north of the main crosscut the ore-shoot was left, but driving was continued for another 75 feet. The lode-fracture is well marked by a seam of pug an inch wide. There is a little galena on the footwall, but no payable ore was met with. At the northern end of the drive a short crosscut was put in to the west, and the porphyroid encountered, but no galena was visible, and work at this end of the drive was abandoned.

The south drive has been extended for 109 feet on a bearing of 210°. The lode pinched out when the porphyroid country was left at a point 106 feet south of the main crosscut. The lode thus extends for 133 feet in a horizontal direction. At a point 53 feet south of the main crosscut a crosscut was driven west for 25 feet on a bearing of 305°. There a short drive was started north and south parallel to the main drive. Some blende galena and siderite was here visible for a width varying from a few inches up to 2 feet. The metal seems to make towards the main ore-body, with which it should junction about 20 feet above the level, the dip being easterly.

The ore in these short drives (12 feet on either side of the eastern crosscut) is displaced by a slide, which is also visible in the main drive. The slide dips south at an angle of about 50°, and the displacement of the lode is apparently about 4 feet. The lower portion of the ore is moved to the west of the upper portion by this amount. The eastern crosscut was continued for another 45 feet eastwards. The porphyroid country was left at a point 48 feet east of the south drive, and the rest of the crosscut is in slate.

These eastern workings were abandoned, as the only ore met with (in the east drive) was lost after being followed a few feet.

At a distance of 109 feet from the main crosscut the south drive turns slightly, and from this point to the end the bearing is 184°. This change of direction is noticeable, as the drive followed the lode-fracture all the way. It would appear that the fissure which traverses the porphyroid at an angle of about 30° from the north-and-south line is merely a local variation. The fracture in the slate does not differ materially in strike from other fissures in the field. This matter is, of course, important in future prospecting work, both in this section and those adjoining.

At the bend in the south drive a winze has been put down on ore for a vertical depth of 56 feet, and a drive 20 feet long put in northwards at 50 feet.

The winze was full to the collar of water, and I could not inspect these workings. It is stated that a slide was met with at this point; and possibly it may be the same slide visible on the level 56 feet north from the winze, and pitching in this direction.

At a point 29 feet south of the winze an easterly crosscut was put in some 10 feet without meeting ore; and 8 feet further south another crosscut was driven west for 17 feet with similar results. Beyond this latter crosscut the south drive extends some 24 feet. The face shows carbonate of iron with galena and blende. The dip is to the westward, at an angle of 60°. The footwall is dense and hard slate, but the hanging-wall slate is graphitic, and the carbonated zone extends into this crushed graphitic slate for about 4 feet.

The main ore-shoot, *i.e.*, that portion of the lode-channel enclosed within the porphyroid, is said to have given excellent ore all along the level. The average width of first-class ore is said to have been 10 inches, while 30 inches of clean ore were met at a point 20 feet north of the winze.

This being correct, there remains a fair bulk of good ore to be yet extracted below this level.

Above the No. 3 level, and between it and the No. 2 level, some ore has been stoped, but the greater portion yet remains untouched. It does not extend to the surface, however, for the shoot is pitching to the south at an angle of about 55°.

The shoot was met with on the No. 3 level, at a vertical depth of 87 feet below the No. 2 level, some 60 feet further south than the corresponding point above.

The width of the lode exposed in these stopes varies from 4 to 7 feet. I saw some good first-class ore along the western boundary of the lode-formation, but the bulk of the ore consists of massive mixed sulphides of the type known as a " pyritic lead ore." The mineral composition has been noted above.

The work done up to the present has proved a roughly rectangular block of ore, extending from the surface to at least the No. 3 level, and from 4 to 7 feet in width. The other dimension is about 100 feet; but the pitch of the shoot makes the length appear some 30 feet greater when measurements are made along a horizontal line.

It yet remains to be proved whether the structure of the lode will alter in depth when the porphyroid zone is penetrated. The nature of the fissure in this rock seems to have entirely controlled the circulation of mineral-bearing solutions, and the slate contains but little mineral matter; but the fissure, of which the upper portion is in porphyroid, must, if its strike and dip continue uniform, pass through slate in depth.

A trench has been made to the south-east of the open-cut for a length of a chain. Some vegetable soil containing a little bog iron ore is exposed. I do not think this is the capping of a lode.

The company has erected a mill on the button-grass plain to concentrate their second-class ore.

Mill Scheme.—The mill is divided into two sections—coarse and fine. From the bin the ore goes to a jaw-crusher, and thence to a trommel, the screen of which carries holes of 13 m.m. diameter. The fines run on. The coarse goes to a picking-table and then to the coarse rolls. There is a topping-jig below taking the "roughs" from the first sizing-trommel (screen apertures 13 m.m. diameter). The tails from the jig are elevated to the coarse rolls, and pass again down the mill. The four sizing-trommels have apertures in the screens of 13 m.m., 9 m.m., 5 m.m., and 2½ m.m. in diameter respectively.

From that which holds the material over 9 m.m. in diameter the ore passes to two jigs. Each of the other two trommels feeds a separate jig. The ore before reaching these latter fine jigs is passed through an upward current separator, and the fines go on to the tables.

Below the last trommel are two spitzkasten, giving two grades of ore. The coarser goes to a Wilfley, and the finer to a Phoenix-Weir table.

Middlings from the table are elevated, and pass to the water-classifier on the fine side of the mill, and are again passed over a Wilfley table.

On the fine side of the mill the procedure is this:—The second products from all the jigs are wheeled back to the elevator, and thence go to the fine rolls, and then the second series of sizing-trommels, the screen apertures of which measure 4 m.m., 2½ m.m., and 1½ m.m. The ore that is caught by the 4 m.m. trommel is returned to the fine rolls by the elevator. The other two trommels supply ore to two jigs.

The ore leaving the last trommel runs to an upward current classifier. The coarse product is treated by a jig and the fines pass to the spitzkasten, and then to a Wilfley table. The middlings from the table are returned to the spitzkasten, and then again to the table.

The concentrates from the mill are mixed with the hand-picked ore to constitute the saleable ore. No distinct grades of mill concentrates are made.

The following assay returns will give a reasonable representation of the value of the mine products. They are from the assay books of the company, and the assays were made during 1907:—

Description of Ore.	No. of Assays Averaged.	Lead.	Silver. (oz.)
		per cent.	per ton.
Gossan (from open-cut)	6	..	34·5
Crude ore	14	5·9	11·6
Hand-picked ore	9	51·9	67·4

Sales of Ore by the Murchison River Silver and Lead Co., N.L.

Date.	Quantity of Ore.	Lead.	Silver. (oz.)	Gold. (oz.)	Net Value. (per ton.)
	tons. cwt. qrs.	per cent.	per cent.	per ton.	£ s. d.
May, 1907.	12 7 3	43·75	57·1	·045	12 10 1
May, 1907.	57 0 1	47·85	64·1	·043	14 1 3
June, 1907.	80 14 3	42·8	55·55	·07	12 6 3
June, 1907.	32 9 1	43·8	55·75	·057	12 8 10
July, 1907.	33 18 0	43·95	59·15	·06	13 4 6
July, 1907.	16 17 1	41·3	55·6	·078	12 8 0
Aug., 1907.	31 7 3	28·5	40·9	·095	8 11 9
Aug., 1907.	29 8 1	34·825	47·15	·09	10 8 6

The other lease held by the company, viz., No. 1980, is that which was formerly known as the Central Farrell.

On this lease there are two parallel lodes, which have been prospected at two levels; and a trench has been cut for a chain where a creek has cut across the outcrop.

The lodes are separated by a narrow band of porphyroid, and are themselves in slate. The dip of the country is westward, and the lodes follow this dip, which is from 60° to 65°.

At the surface the strike seems to be about N. 4° W., but the underground workings show the strike to be due north and south.

The creek section shows slate on the western side, with a lode 2 feet 6 inches wide to the east of it; then 9 inches of slate, followed by 10 feet of porphyroid. The footwall of the porphyroid shows quartz, which may mark the position of the eastern lode; but the work has ceased at this point. The lode formation shows a little fahl-ore, now much decomposed and discoloured.

The upper tunnel is driven eastwards on a bearing of 266°, and passes through slate and crushed grit. The total length of this crosscut is 234 feet.

At a distance of 126 feet from the mouth a drive runs due north on the first ore-body. A rise has been put up for 15 feet at a point 110 feet from the main crosscut, where a little metal was met with. Some 34 feet north of this point a winze has been put down. It was full of water at the time of my visit.

At a distance of 29 feet north from the winze a crosscut has been driven for 23 feet, where the second lode was encountered, and driven on for 20 feet northwards. This lode is 4 feet wide, and has well-defined walls. The lode-matter is graphitic slate, with numerous veinlets of carbonate of iron. The footwall is a hard siliceous slate.

The main drive was carried for 33 feet north, past the eastern crosscut, and still on the lode-channel, which shows quartz, siderite, and a little galena. The width of the zone of crushed graphitic slate carrying these minerals varies from a few inches up to 3 feet 6 inches.

The main crosscut did not meet with any ore after traversing the second lode.

The lower-level workings are 60 feet above the button-grass plain, and 50 feet below the upper workings. The adit level is driven for a total distance of 285 feet, and intersects both lodes.

The first was cut at a distance of 212 feet from the mouth of the adit, and there are 15 feet of country between it and the second lode.

The first lode was driven on northwards for 15 feet. The lode-formation appears to be about 4 feet in width, and similar to that on the upper level, but no galena was visible. The drive was abandoned here, and the lode driven on southwards for 73 feet. The formation is well defined all the way. It is about 4 feet wide, and has clean walls. Very little metal is now visible, but a few splashes of coarse-grained galena occur near the south end on the back of the drive. None was showing in the face.

A drive was started on the eastern lode and carried 6 feet before being abandoned. The lode is well marked, and is in graphitic slate. The ore is accompanied by veins of quartz and siderite, and consists of galena, resin, or ruby blende, fahl-ore, and copper pyrites. The fahl-ore would account for the high assay values which have been recorded of the ore in this mine.

No work was being done on the section at the time of my visit, and the old workings were very much discoloured. The amount of ore in the mine could not be determined, nor the proportion of fahl-ore to the galena. The only spot where any appreciable amount of metallic minerals was visible was at the point where work has been done on the eastern lode on the lower level. There I saw a vein of an inch and a half of the fahl-ore at the sole of the face.

Some rich returns are said to have been obtained from the ore taken from the winze on the upper level. In all, about 120 feet of backs would be obtainable from the lower level to the highest point of the outcrop.

(4)—THE MURCHISON EXTENDED MINE (LATE NORTH MURCHISON).

The company holds one section (No. 1075-M), which is registered in the name of E. T. Midwood.

There is a fair amount of surface prospecting work done on this section, but no payable lode has yet been located.

Near the centre of the western boundary-line there has been some trenching along a creek which runs westwards, and a little galena has been disclosed. A main adit has been driven east on a bearing of 91° for a distance of 143 feet.

At 120 feet a lode was met with. This is a brecciated zone of black slate, in which much siderite is visible, and a little galena and fahl-ore. It seems highly probable that this ore-body is on the line of the Central Farrell fractures, but whether a second lode corresponding to that in the Central Farrell property exists I could not determine from the work which has been done.

A considerable amount of trenching has been done on the southern boundary of the section. Some carbonated black slate has been located which carries some pyrites and traces of galena.

Further east of this place trenches have been carried up the hill in steps to a height of 430 feet above the button-grass. The top few feet show a silicification of the country rock, and in the quartz veins a little chlorite and pyrites, but no galena. The occurrence seems similar to that in the South Murchison eastern tunnel. I could see no galena nor any siderite associated with the quartz. The occurrence does not seem to me likely to prove of commercial value. The bearing of this quartz zone is about 175°.

(5)—THE MACKINTOSH COPPER AND GOLD MINING COMPANY, NO LIABILITY.

The company holds two 80-acre sections, viz., Nos. 3221-93M and 3223-93M.

The workings on these sections have been carried out in both lead and copper-bearing lodes, which are situated along a line on the western portion of the two sections.

The most southerly workings are in the extreme south-west corner of the southern section, and within 150 feet of the most northerly workings of the North Mt. Farrell Mine. The ore-body is clearly a continuation of the North Mt. Farrell lodes, and it seems continuous right through this southern Mackintosh section and part of the northern.

The company has let several tributes, and the most southerly workings are being carried on by J. Geddes and party.

An adit is driven eastwards from the western boundary-line of the section on a bearing of 91°. The country traversed is all slate, and before meeting the main lode three minor lodes were cut and driven on for a short distance. All of these appear to be merely branches of the main lode, and their strike is N.W. and S.E. From the second branch-lode a rise has been put in to the surface. No work was being done on any of these occurrences at the time of my visit.

The main lode was driven upon southwards for 200 feet on a bearing of 9°. A rise has been put to the surface and a winze sunk on the ore. There are said to be from 1 to 6 inches of first-class ore here, and with it a few feet of seconds.

The dip is to the west, and the footwall is of quartz, and barren.

The width of the lode varies from 4 to 9 feet. Stoping is being carried on at a point 25 feet from the south boundary. The formation is a brecciated zone of quartz and galena, and fragments of slate scattered through pug. Some first-class ore is found on the foot and hanging-wall side. The better ore is said to be on the hanging-wall. These veins of firsts are usually in short overlapping lenses.

The present stopes are 30 feet above the level, and there are another 100 feet of backs between the workings and the surface. The ore is partly bagged in the stopes, and the best seconds are hand-jigged.

Some second-class ore is left in the stopes for filling, and the remainder is stacked on the tip with the seconds from the jigs.

The following table compiled from the sale-notes of the tributors shows the grade of ore, and its value:—

Date	Net Weight of Ore.	Assay Value.		Total Value (per ton.)	Metal Quotations.	
		Lead.	Silver. (oz.)		Lead. (per ton.)	Silver. (per oz.)
	tons. cwt. qrs	per cent	per ton	£ s. d.	£ s. d.	d.
June 11, 1907 ..	10 1 1	53·0	54·3	20 7 2	20 15 0	32·00
July 23, 1907 ..	11 6 0	58·2	68·7	21 19 8	22 0 0	32·06
Aug. 19, 1907 ..	11 11 3	58·5	73·4	21 12 7	19 15 0	32·94
Sept. 20, 1907..	15 9 2	60·5	78·8	22 13 6	19 17 6	32·44

In this southern section of the Mackintosh property there are two other places where the creeks have exposed ore, and it is probable that they are on the same lode as that worked by J. Geddes and party.

In these, no work was being done at the time of my visit. Some good second-class ore was visible in the workings, but the lode is not suitable for a small tribute party, although it could doubtless be profitably worked on a larger scale. The lode-stuff in both of these workings is similar to the bulk of the good second-class ore in the North Mt. Farrell Mine.

In the south-western corner of the northern Mackintosh section two lodes have been located by trenching in a creek. A tunnel has been driven from a point a little further west. The bearing is 113°, and the country is clay schist for the first 52 feet. After traversing 81 feet of slate which lies east of the clay schist, this tunnel intersected the first lode. Here good ore is said to have been met with, and a few stopes have been carried almost to the surface, some 85 feet above the level. The first-class ore was sold and the seconds stacked on the tip. The stopes are 40 feet long, and a rise from over the adit was taken right to the surface.

The drive on the ore-body has a bearing N. 10° E. It has been extended southwards for 20 feet, but northwards for 90 feet. The greater portion of this level is full of water dammed up by a heap of mullock, and consequently inaccessible. The lode-channel seems to be well marked, though the lode varies. The footwall is well defined, and on it the first-class ore is obtained. The hanging-wall is indefinite, and a shot put into the apparent country may at any time reveal ore.

At winze has been put down at a point a few feet north of the main crosscut to a depth of 26 feet.

The ore-body here dips more steeply. It is 8 feet in width, carrying about 6 inches of clean firsts on the footwall side and a band of some inches of pug, which contains brecciated steel-grained galena. This latter is hand-jigged.

During my visit some work was done by a tribute party on the ore in this winze, but the water could not be kept under and the party were compelled to abandon the tribute. Nothing could be done with the second-class ore, although it was of splendid grade. Of the hand-picked firsts and jigs some 3 tons of ore were sent away. The average value of this ore is said to have been £16 per ton.

Fahl-ore is mentioned as having been seen in small amount in the ore taken from this lode.

The main crosscut has been driven another 100 feet eastwards beyond the first lode. At 42 feet from the latter a second lode has been cut carrying second-class ore. This has been driven on for a short distance north and south. The lode here appears to be making towards the first lode, with which it would junction at a point further south. A shaft was started in this ore-body at the surface, and is said to be down some 36 feet. Some good second-class ore is tipped round the collar of the shaft.

The Mackintosh property, therefore, seems to carry a length of lode and lead ore of such grade that mining operations on a large scale would be highly profitable. It does not possess the topography that would make the mining on a large scale possible without the sinking of a shaft; yet the bulk of second-class ore and the readiness with which it could be concentrated are in favour of this treatment on an extensive scale. The ore is physically well adapted to concentration, and closely resembles the North Mt. Farrell second-class ore. The present inactivity on this property is deplorable.

At a point further north in the northern section of the Mackintosh lease, and 250 feet from the western boundary, two lodes have been exposed in the bed of a creek.

The country-rock is a pale clay schist, which has been silicified, and which carries also veins of quartz. There is a little carbonate of iron with the quartz, and the metallic minerals present are iron and copper pyrites. The ore is dense and hard, and the copper pyrites is found disseminated in fairly coarse blebs throughout a zone about 8 feet wide. The strike appears to be a few degrees west of north, but very little work has been done, and it is difficult to ascertain the strike and dip.

A shaft has been sunk at a distance of 25 feet from the creek on its northern bank to a depth of 35 feet. It was full of water when I visited the property. The country-rock is the same as that exposed in the creek, viz., clay schist.

The slate is 50 feet to the east of this shaft, and although a number of trenches have been cut in the creek bed on the east of the copper lode no trace of mineral has been found.

On the western side of the lode above mentioned, and distant about a chain, there is a second copper-bearing zone, of a similar character. It is some 3 feet wide, and carries both iron and copper pyrites.

This is the most southerly point at which copper is visible along this line, *i.e.*, in the absence of a much larger proportion of galena.

It does not appear from the work so far done at this point that the ore will give profitable returns as a copper proposition. The occurrence is, however, worthy of being further prospected.

(6)—THE FARRELL BLOCKS.

The company known as "The Farrell Blocks" holds two sections, which are registered in the name of E. Goldsmith, and are numbered 2397-M, 79 acres, and 2820-M, 80 acres:

On the western of these two sections (No. 2820) no work has been done. There does not seem much prospect of the Mackintosh lead lode passing into this ground at a reasonable depth. The dip is certainly to the westward, but the winze put down on the western Mackintosh lode shows that the tendency of the lode is to become more nearly vertical than it was between the adit level and the surface; and the lode is distant about 350 feet from the western boundary of the Mackintosh section.

The northern section, No. 2397, occupies a better position with regard to the lode system.

On the boundary-line between this section and the northern Mackintosh section there is a small quartz blow which may be connected with the outcrop cut by the creek a short distance northward; yet the whole area here is highly contorted, and the creek beds show quartz veinlets, which run in all directions, and many of these carry no trace of metal.

In the south-west corner of the section a lode-formation has been cut in a small creek. It is a zone of highly-contorted clay schist, which has been impregnated with silica, and which carries copper and iron pyrites. A little galena is visible in the lode.

On the northern bank of the creek, some 30 feet away, a shaft has been put down 30 feet. No metal was encountered in sinking. The rock penetrated was the clay schist very much contorted, and carrying a little carbonate of lime. The shaft is now full of water. Some 65 feet of backs could be obtained here by driving an adit from the west, but such work is not at present justified. A crosscut from the bottom of the shaft would also prove the lode. However, until the lode is proved to be continuous by other trenches at the surface, the exploitation at a depth should be held over.

Trenches have been cut in the bed of the creek which traverses the middle of the section for a distance of about 7 chains. The country rock exposed is for the most part slate, which is very much contorted. It is sometimes graphitic, and contains a little siderite and veins of quartz. The latter are flat veins dipping mostly to the east, or follow the contortions in the slate. No metallic mineral other than iron pyrites was visible in the main part of the trenches. However, in the southern end of the workings, near the junction of the slate and clay schist, some good galena was obtained. It cut out in the bottom of the trench, however.

The work done at this point has clearly been influenced by the idea that the galena can only be expected to be found within the slate boundaries. The trenching has here been carried out to the east of the proved line of fracturing of the area, and I should recommend that in future prospecting the trenches be continued for a short distance to the west of their present extent. It is possible to obtain 60 feet of backs at the point where the galena was met with in the trenching by 150 feet of driving from a point a little lower down the creek. Still, the trenches might be extended westwards with much less expenditure.

(7)—THE SECTIONS ON THE NORTH-WESTERN FLANK OF MT. FARRELL.

On Section No. 3010, which is registered in the name of D. Powell, some trenching has been carried on on both banks of a large creek which runs through the section, but without result. The section lies to the east of any lodes yet discovered.

On Section 2905, which adjoins the northern section of the Mackintosh property, a trench has been cut in the creek bed, but abandoned in river wash, which consists of fragments of conglomerate from the mountain.

In the south-eastern corner of Section 2909, on the eastern side of the Mackintosh River, some trenches have been cut in the bed of a small creek. The river bank is very steep at this point. The upper trenches expose a highly contorted graphitic slate, with irregularly distributed veins of quartz, siderite, and galena. Some of these veins dip west and others flatly to the south.

On the water's edge a few shots have been put into the bank, and show the same clay schist which is found in contact with the slate all along this line; and in the rock are a few scattered splashes of galena. No further work has been done on the section.

Passing northwards along the eastern bank of the Mackintosh River the next two sections are registered in the name of G. E. Butler, and are numbered 2796-M, 80 acres, and 2892-M, 40 acres.

On the 80-acre section some work has been done in the past near the northern boundary. At the time of my visit nothing was being done.

The fault-plane referred to above traverses this section, and a creek is situated on the line of the fault. Some trenching had been done in the slate near the track, but the sides had fallen in, and nothing was visible of the bottom. A tunnel has been started into the mountain and driven 30 feet in a direction bearing E. 16° S. The tunnel was begun in a coarse quartz grit, and was abandoned when the massive conglomerate of the mountain was encountered in the face. There are some quartz veins in the grit carrying iron pyrites, and in one place, near the entrance, some galena.

However, there does not seem to me much inducement to continue driving, in spite of the presence of a small amount of galena; for what metal was discovered was enclosed within a member of the slate series, and it has not yet been proved that any of the lode-fissures are continuous into the massive conglomerate. This section was formerly known as the "Metropolitan."

At the extreme north end of the mountain, on Section 2873-M, registered in the name of C. R. Lynch, some work has been done to try and locate an ore-body said to be visible in the river at low-water. This latter was not to be seen during my visit. A short tunnel has been driven in the river bank with a bearing of S. 12° W. The work has revealed slate with quartz and iron carbonate veinlets, but no galena could be detected. The tunnel runs with the cleavage of the slate, and a crosscut has been put in towards the east for 14 feet. The slate here, too, carries quartz and siderite stringers.

A trench above the track on the Mt. Farrell side of this tunnel shows only slate.

On the eastern boundary of the section, near the cage crossing to the Tullibardine area, a short trench has been cut in a crushed grit carrying arsenical pyrites. The weathering of this mineral has produced some limonite at the surface; but no sign of a defined ore-channel was visible when I last saw the work.

The position of this section appears to be a little to the east of the line of fracturing of this area.

(8)—The Tullibardine Company.

The company holds three 80-acre sections, all of which are registered in the name of J. McPhee, viz., Nos. 2058, 2592, and 2593.

The greater portion of these sections is covered by unconsolidated river wash, through which the main creeks have cut their way and exposed the underlying rocks.

The felspar porphyry forms a series of steep hills on the western boundary of the property, and the rock underlying the river alluvial is slate or pale clay schist. The strike of the belt of clay schist is, as far as could be determined, considerably east of north. Whether it is the northward continuation of the belt of similar rock which traverses the Mackintosh and Farrell Blocks sections, I could not on this visit definitely decide. However, I think it will prove to be portion of what was originally one continuous formation dislocated by the fault which traverses Section 2796. The fault-plane will, I think, be found to be the spot at which the strike changes. If so, the fracture system which has controlled the position of the ore found on the Tullibardine is probably portion of the same fracture system as that which traverses the Mackintosh area and the Farrell Blocks, and which has been traced to the river bank in Section 2909. In other words, the lode channel, as well as the country rock, has probably been dislocated by the fault which cuts across the country on Section 2796.

In the Tullibardine area the slate occurs on the west as well as on the east of the clay schist. This was the case on the North Mt. Farrell lease (3262), but at the northern locality there is a much greater thickness of slate on the western side.

The main workings are situated in the south-eastern corner of the central Section, No. 2058, on the banks of the large creek which traverses the section. The creek takes a sharp bend from an easterly to a southerly course at this point, and a face has been broken down from the southern bank just at the turn. This cut is 25 feet in length, and exposes the country to a depth of from 5 to 12 feet below the surface-soil. The clay schist is very waxy in appearance, and carries numerous intersecting quartz veins, which carry copper pyrites and some secondary copper ores. The quartz veins vary from half an inch up to a foot in width, but they make and pinch within very short distances. The country rock contains greenish patches, the green colour being due, not to copper, but to a green sericitic mica.

In a complex lode-formation of this character the strike and dip are difficult to estimate. One very strong vein, which has been followed down in a winze, strikes N. 25° E., and dips east at 80°; but other veins dip towards the west.

The copper pyrites is very clean and free from iron pyrites, and is in places quite coarse and massive; and, resulting from its alteration, malachite and bornite are common in the lode-formation.

A winze has been put down on the eastern end of this face for 7 feet. The same types of country and mineral vein persist. In addition, the schist is thoroughly impregnated with very finely divided native copper where it is enclosed between a cupriferous quartz vein and a plane of separation along which surface waters have been circulating. The schist is at this place deeply stained with limonite.

A little further up the creek to the westward a couple of small cuts have been made in the bank, and show a little copper pyrites. One of these veins shows a fair amount of ankerite* with the quartz, and serves to show the connection between the copper ores and the lead ores. At this place, 15 feet west of the main face, the clay schist has a belt of slate intercalated with it. The slate dips to the westward.

In all, the veins which show copper extend to a distance of 100 feet west of the main face exposed.

Across the creek from the main cut there are two trenches which show quartz veins or silicified schist carrying copper ore. These serve to indicate that the copper bearing zone is at least 150 feet in width.

Where the creek turns to run southwards there is a strong quartz vein carrying coarse copper pyrites. On this, Pearce, who first held the property as a reward claim, had sunk a shaft 20 feet, but the creek at the time of my visit made it impossible to investigate this work. Pearce had apparently turned the creek to the west, but the later work had thrown it over again, so that the water could not be baled out of the shaft.

Alongside this old shaft a tunnel has been driven eastwards on a bearing of 126° in slate, which here junctions with the clay schist. The cleavage-planes of the slate at the entrance of the tunnel dip at 60° to the east, but in the face they dip at 80° to the west. The slate, considered as a whole, will be found, I think, to dip to the west, as does the small band intercalated in the clay schist.

At 75 feet the tunnel cuts through a band of silica 2 or 3 inches wide, and striking N. 5° W.

Further in, 8 feet from the face, the country becomes fractured in all directions, and the fractures are filled with siderite. In the face, further veins of quartz appear striking from 30° to 40° east of north. These quartz veins carry copper pyrites and some odd splashes of galena. The tunnel was here abandoned.

Another tunnel was started, 100 feet south of the first, and across the creek. It was driven west on a bearing of 299° for 35 feet, the intention apparently being to prove the veins of cupriferous quartz exposed in the main cut on the creek bank. The only copper veins met with were some small ones in the approach. The country intersected by the tunnel is clay schist, much crushed and fractured. Some bands of the schist are a little darker than others, and resemble more closely an ordinary slate. Vertically above this tunnel a couple of trenches have been cut in the creek bank, and show a few quartz veins carrying copper pyrites.

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* Ankerite is a carbonate of lime, iron, and magnesia.

The tunnel should certainly be continued for another 100 feet to prove whether the veins of copper-bearing quartz exposed by the main face are continuous. So far only the width of the formation has been indicated by prospecting operations.

The creek turns again to the east a little way further south, and some trenching should be done here to prove whether the lodes cut by the eastern tunnel are of any horizontal extent.

In the south-western corner of the northern section, a trench one chain long has been cut, and a hole put down some 6 feet in the centre of it. The country rock is the clay schist in which green patches of sericite occur, and which is thoroughly impregnated with ankerite. A little quartz is present in veins and small lenses, but no copper accompanies it at this spot.

Near the centre of the southern section, No. 2592, there is a short trench upon a quartz outcrop. The surface cover is considerable, and only a few irregular masses of quartz are visible. There is a small amount of ankerite and both copper and iron pyrites included in the quartz. I noticed also some fragments of included slate, like those in the quartz reef on the Mt. Farrell leases. The outcrop is poorer than that in the north-eastern corner of the section, but seems worth prospecting further.

A few chains to the south-east a trench, 40 feet in length, has been cut. It shows the usual alluvial cover resting upon a dark-coloured wavy slate. There is some quartz in the slate, and on the sides of the trench I saw some slate with veins of siderite and a little iron pyrites. This may come from the end of the trench now filled in by the fallen alluvial from the sides.

On the eastern bank of the creek, south of this latter place, a trench 8 feet long exposes a lode which differs from the copper formation in a striking way. The country rock is the same clay schist, with green sericitic mica on the divisional planes, and carrying a quantity of carbonates, but no silica. The metallic minerals are galena and blende.

The strike measured over the short length exposed is between 10° and 12° east of north. The dip is to the westward. No copper ore at all has been seen at this place.

The ore strikingly resembles that which comes from the vughs in the quartz reefs of the Mt. Farrell Mine.

There is a vein, about 10 inches wide, of ore which carries the metallic minerals (galena and blende) in bands up to an inch in width, and also scattered through the gangue.

A trench, 6 feet deep, was cut at a distance of 60 feet to the southward to test this lode. The sides had partly fallen in and were not visible. On the banks were some pieces of greenish schist carrying veins of quartz and carbonates, with iron and copper pyrites, but no galena.

There is little else done on this area. In the bend of the river, just south of the boundary-line of Section 2593, a trench has been cut in the clay schist, but no ore is visible.

The copper ore of the central section is in itself of very promising appearance; but the quantity available cannot be estimated even roughly until some further prospecting work is done, with a view to proving the length of the lode-formation. The amount of ore carrying native copper cannot be expected to be considerable.

(9)—THE WHITE HAWK DISTRICT.

(*a*)—*The White Hawk Mine.*

The White Hawk property includes the sections numbered 2330-M, 42 acres; 2331-M, 80 acres; and 2332-M, 47 acres. All of these are registered in the name of R. P. Symmons. The 80-acre section contains the workings.

At the centre of central block (No. 2331) is the lode, which was first located by Tom Farrell, and the section was his reward claim. His original workings have been almost completely obliterated by recent prospecting operations. The ore outcrops at the foot of a steep hill of limestone.

A short drive has been put in on a bearing N. 30° W. on the lode. A body of gossan carrying some galena and cerussite (lead carbonate) was met, and a winze put down to a depth of 5 feet on the lode a few feet from the entrance.

At this point the lode seemed to dip east at about 40°, and to strike about 30° west of north. However, very little information could be gathered from the amount of work done. The shape of the ore-body was not clear. On the northern wall of the winze there was a good seam of galena and blende, but metal was absent from the southern wall. The ore gave me the impression of following the joint-planes of the limestone, but no length of lode can be said to have been proved.

Work has been abandoned at this particular spot, and a crosscut has been driven westwards for 141 feet on a bearing of 265°, in the hope of cutting another ore-body.

The first discovered outcrop of ore is situated at the approach to this tunnel. No other metallic mineral than iron pyrites was visible to the west of the lode at the entrance. Galena is said to have been seen while work was proceeding, but I did not find any in the workings.

The drive cut across some cavities in the limestone, which are still visible in the back, and down which the surface drainage brings a quantity of mud.

On the steep hill side which forms the western bank of the White Hawk Creek south of the centre of the section, there are two places where a small amount of galena, associated with zinc-blende, is visible. One is near the top of the hill, and carries some coarse-grained galena with semi-oxidised blende. The strike and dip could not be ascertained. The other occurrence is some 10 feet above the creek level, and shows galena following the joint-planes, and dipping east.

The metal appearing here is, in my opinion, not connected with any other lode yet located in this area.

Near the south boundary-line of this central section a mass of gossan was discovered, which, on being broken into, was found to carry veins of galena. The dip and strike could not be determined accurately, and the possibility of the veins now visible being of a secondary nature is so strong that such observations could hardly be of any value.

A tunnel was started from the creek bank, which is here precipitous, to cut the lode at a depth of 85 feet below the outcrop. The tunnel is on the same level as the other tunnel in the centre of the section, but here the creek is about 25 feet lower. The bearing of the tunnel is 256°, and it has been driven westwards. The limestone traversed dips at 40° to the west. Joint-planes crossing the bedding-planes at the entrance to this tunnel are apt to give a false impression of the structure; but the joints become less pronounced as the surface-rock is left. The limestone shows numerous seams of calcite running with the bedding-planes, and opening out here and there into lenses from a quarter of an inch to half an inch wide, and from half to three-quarters of an inch long.

The tunnel at 40 feet from the entrance met with a body of semi-oxidised ore. There was some crystalline calcite and a mass of gossan carrying galena and cerussite. On the sole of the drive this ore looked very well. A winze had been started during my visit to the district, and was down 9 feet on ore. A chamber was cut on the southern side of the crosscut, and the winze was following the ore, which at this place is dipping eastwards. The dip varies, becoming much flatter in the bottom of the winze. On both hanging-wall and footwall there is pug carrying fragments of limestone. The ore consists of gossan, carrying blende and galena in bunches through it, and at the bottom of the winze at the time of my visit there were 2 inches of clean galena in the gossanous material, which was dipping east at 35°. The amount of ore was increasing as the workings were carried down, and there appeared to be signs of the lode increasing in width on the southern side of the winze.

The adit was continued past this spot, and when I visited the mine the work of driving westwards was proceeding, at a distance of 123 feet from the entrance.

This tunnel at 80 feet passed through a slide-plane, dipping with the country, and carrying fragments of limestone set in a paste of soft, wet, yellow clay. Some cavities of solution were passed through, similar to those met with in the northern tunnel. Where the drive intersected one of these, at 103 feet from the adit entrance, a mass of gossanous material was met with, which carried galena. This fragment of ore may have been derived from the upper portion of the body of ore cut at 40 feet, and may have rolled down the open cavity to its present position.

Beyond this point the last 20 feet of the tunnel are in very dense limestone, in which the bedding-planes are not decipherable, but which is traversed by a number of very irregular joints. Veins of calcite were present, and in them a little iron pyrites.

The work done at this end of the section has given very inconclusive results. There are two bodies of ore—the surface gossan, some 85 feet above the tunnel; and the ore-body on which the winze is sunk. But the connection between the two, if any exists, has not been proved. The tunnel was being driven in country which, at the time of my visit, showed no indication of the presence of ore. It would therefore seem advisable to follow the surface gossan down, to try and determine the strike and dip. Until more is known about this surface ore it appears to be inadvisable to prospect for it by means of a tunnel.

On the northern boundary of the section in the creek bed a trench has been cut for a few feet. The massive limestone here contains some crystalline calcite, but I could see no trace of any lead ore.

The following assay returns will show that the metallic contents vary considerably. This is no doubt owing to the fact that the lodes are subject to the leaching action of surface waters.

Description of Ore.	Lead.	Silver (per ton).			Zinc.
	per cent.	ozs.	dwts.	grs.	per cent.
Mixed sulphides	41·8	12	5	0	20·5
Gossan	39·2	15	16	5	—
Galena (from gossan)	66·7	11	3	5	—
Galena (from gossan)	49·5	9	13	6	—
Galena (from winze)	39·1	8	15	0	—
Galena	77·2	53	1	16	—
Galena	50·51	27	17	8	—
Galena	60·6	6	7	9	—

(*b*)—*Other Sections on the White Hawk Creek.*

On the Section 3367-M, 72 acres, charted in the names of R. P. Symmons and C. R. Lynch, a gossanous cap on the limestone has been found. Some trenching has been done on this outcrop, starting from the small creek that runs southwards to join the main creek near at hand. The trenching shows a number of veinlets of calcite, carrying galena, blende, and copper pyrites. These dip to the west into the limestone, and with the bedding-planes. From the amount of work that had been done, these veinlets gave me the impression of being "droppers" from a lode crossing the bedding-planes. A trench across the formation in an east-and-west direction would afford valuable information.

There is no further work done on this or the other sections charted in the same names.

(10)—THE SOUTH MURCHISON SILVER AND LEAD MINING COMPANY, NO LIABILITY.

The company holds one section, No. 704-M, of 73 acres, upon which a considerable amount of prospecting has already been done, but hitherto without any successful issue. The object of the work done is to pick up the southward continuation of the Murchison lode. It has been already pointed out that the lode-channel after passing through the porphyroid in the Murchison low-level workings turns and follows a direction only a few degrees west of south. If this strike continues unchanged, the lode-channel should traverse the South Murchison ground, provided that it is continuous for that distance. The surface cover of vegetation is extremely thick at this place, and the prospecting work has been considerably hampered by its presence.

A lode is said to have been discovered in the river bank just east of the crossing. This formation is said to have carried galena in a gangue of quartz and siderite. At the time of my visit the river was at first too high to see this lode, and later, when the water had subsided, it was deeply covered with silt.

Two lines of trenches are cut at a point near the south boundary-line of the Murchison section, but no definite lodes have so far been located. Some siderite is visible in dark graphitic slate, and with it a little quartz and iron pyrites. This spot is a little to the east of the upper tunnel, and is the strongest evidence I saw on the section of the proximity of a lode likely to contain lead.

The tunnel just mentioned was driven westwards on a bearing of 280°. The country penetrated is a dark-coloured slate, slightly contorted. The tunnel has been carried for a total distance of 107 feet. At 70 feet a drive north was put in some 27 feet, and a further crosscut was driven north-west for 27 feet. The face of this crosscut showed massive quartz, with a little calcite and pyrites. The quartz contains some chlorite. No galena was found in these workings, and they have been abandoned. The company, at the time of my visit, was exploiting the more easterly portion of the section by a low-level tunnel. This starts from the river bank at a point 17 chains N.N.E. of the corner peg on the river bank.

The tunnel is driven west on a bearing of 270°, and had been extended some 160 feet when I visited the property. There is a dark slate at the approach, and then for 150 feet the adit is in a pale-coloured clay schist, not different from the slate except in colour. A few veins of quartz were intersected, carrying some chlorite and associated with calcite. Some of the veins showed a few splashes of blende and galena.

At 150 feet the tunnel passed into a belt of porphyroid, which continues up to the face of the drive.

The company expected to cut the lode by this tunnel with 100 feet of driving, but events have shown their estimate to be much too small. The width of the felsitic rock has not yet been proved at this point, and the surface vegetation is too dense to settle the matter till some further trenching is done. The lode for which the company is driving is said to be in slate where it was picked up on the river bank. Yet this does not necessarily mean that the lode will continue in slate. The felsitic rock may carry the lode if the fracture persists and crosses over into it from the slate. The upper-level tunnel would appear to be situated just to the westward of the belt of rock said to contain the lode. Had it been 100 feet further to the east much more information might have been obtained. The configuration of the country is less favourable at this point. Still, a site for the lower-level tunel might well have been obtained further west than the one selected.

(11)—THE OTHER SECTIONS NORTH OF THE MURCHISON RIVER.

On the remaining sections charted on the map accompanying this report practically nothing has been done.

A few cuts have been made along the river bank on Section 2945, registered in the names of R. Green and A. King. Galena is showing in two places in a lode-formation which consists of slate cemented together with carbonate of iron and quartz. This latter occurrence of ore may have some connection with the western lode, which has been located across the river on Thomas' Blocks.

(12)—THE THOMAS' BLOCKS SILVER MINING COMPANY, NO LIABILITY.

This property consists of three sections, viz., 2808-M, 80 acres (lessee, C. W. Thomas); 2850-M, 80 acres (lessee, C. Thomas); and 2918-M, 20 acres (lessee, G. O. Smith).

The main portion of the leases is situated on typical schistose porphyroid, but the slate occupies a large area of the northern section (2808).

Work on the lodes found on these properties has only been in progress for a few months, and thus far nothing is known of the behaviour of the lodes in depth.

There are certainly two lodes on the property, of which the eastern one is the principal.

This main lode, at its outcrop near the northern boundary of Section 2808 in the bend of a creek, showed about 14 inches of banded ore, in which were 4 inches of clean steel-grained galena on the hanging-wall side. The metallic minerals occurring with the galena at the surface were blende, copper pyrites, and iron pyrites. The gangue minerals were quartz, ankerite, and fluorspar.

It was decided to exploit the lode at this spot, and with that object a shaft was sunk at the site of the outcrop first located. This shaft was only just started at the time of my visit, and some difficulty was experienced in keeping it clear of water. There were a few inches of very good ore, consisting of galena and copper pyrites, in the bottom of the shaft. The amount of copper pyrites was not large, but all the ore I examined carried blebs of it.

A point has been chosen about 250 feet further down the creek from which to drive for the lode. Near this approach there was a small vein of a quartzose character, which showed a little galena and blende. In cutting a magazine at this point, the ore was not found to make into body of any size. It is probably an off-shoot from the principal lode.

The first few feet of the tunnel are driven in a southward direction, and it then turns away with a south-west erly bearing to intersect the lode near the shaft sunk from the surface. The tunnel was begun in slate, which gave way within a few feet to a wavy porphyroid. Galena was visible here and there on parting-planes in this rock, which clearly shows the results of alteration by vein-forming solutions. The main lode-channel had not been reached at the time of my visit. When the lode is cut at this point much more information should be afforded. The ore at the surface seemed very free from oxidation on the whole, but a sample from greater depth is needed for comparison.

I have been shown since leaving the field some of the ore from the shaft, which contained a considerable proportion of fahl-ore. The assays made of samples taken from this place gave these returns:—

Silver (per ton).			Lead
ozs.	dwts.		(per cent).
102	18	...	65·4
215	0	...	69·5
201	0	...	—

The discovery of the fahl-ore here seems an excellent sign, and if any quantity of this mineral is commonly associated with the galena of the lode, an ore with a silver content much above the average will result. The increase in the silver content with recent deeper development is notable, for earlier assays of material taken from the outcrop are said to have shown only from 27 to 50 ozs. of silver to the ton.

What would appear to be, in all probability, portions of the same lode as this main one just described outcrop at several points on the slopes which rise gradually from the the river towards Mt. Murchison.

One of these outcrops is situated within the southern section (2850), and close to the south-eastern corner of Section 2808. Very little of the lode was visible at the time of my visit, and the character of the ore seemed a little different from that at the principal workings. It was dense and quartzose, but carrying two bands of galena, making in all about 6 inches of second-class ore. Trenches at intermediate points are necessary to prove definitely whether these southern outcrops are on one and the same line of lode. The trenches would also serve to locate the better shoots of ore for exploitation.

In the south-western corner of the northern section the "western lode" has been exploited by a trench. The lode runs N. 25° W., and is in the same country rock—porphyroid. A trench some 50 feet in length and 8 feet deep has been cut. The metal occurs on a good wall as a narrow seam 1 to 2 inches in width. It is free from non-metallic gangue minerals, but both iron pyrites and blende accompany the galena.

No height of backs can be obtained at this point by tunnelling, and it will be probably found more advantageous to carry a trench on the line of the lode as at present, and to sink on any good shoot of metal that may be met with.

In the north-west corner of the south section there is some gossanous material on the surface which may be derived from this western lode.

(13)—THE TULLAH SILVER AND LEAD MINING COMPANY, NO LIABILITY.

The company is engaged in exploiting a lode which has been discovered on Section 2925-M, 80 acres, registered in the name of E. Pennefather.

The lode has been exposed by some 30 feet of trenching in the creek which traverses the southern portion of the section. At the surface it appears to be of a composite character, consisting of numerous short lenses and bands of galena, blende, and iron pyrites, in a zone of altered felspar porphyry. The width at the surface is about 15 feet, and the strike, as far as could be ascertained, N. 8° W. There is some good milling ore visible in the trenches, of lode. As already stated, some further intermediate trenches are required before these different outcrops can be regarded with certainty as being on one continuous lode. Still, the probability that they are on the one lode is very great. The line of the lode seems on the map to bend away a little towards the east; but it is to be remembered that the country is rising here towards the heights of Mt. Murchison, and the dip of the lode at Thomas' Blocks has been shown to be to the westward.

Just outside the south-eastern corner of Section 2850, of the Thomas' Blocks lease, there is an outcrop of the lode. The country rock is still the schistose type of the porphyry. Galena is visible at the surface, and some iron pyrites in a siliceous lode.

Still further south there is an outcrop in the creek, on which some work has been done, and in which a very promising lode has been disclosed. It is a complex formation, from 14 to 18 inches in width, consisting of second-class ore with narrow veins half an inch wide of clean galena on the walls. With the galena are its associates, characteristic of the lodes on the field, viz., blende and both copper and iron pyrites.

The country rock is here no longer schistose, but massive quartz-felspar-porphyry. The hanging-wall is but little altered, and is pink; but the footwall is greenish, and carries streaks of metal in the sericitized zone. This occurrence is 720 feet, by aneroid measurement, above the river.

Still further south, and a chain inside the boundary of Section 2864, is an outcrop showing disseminated galena, blende, and iron pyrites over a lode 18 inches wide in the quartz-porphyry. This spot is 875 feet above the river.

Further up the hill still, and 960 feet above the river, there is in the creek a greenish lode some 8 inches wide, carrying pyrites and galena.

The south-western portion of the southern section contains two occurrences of ore, which have had a little trenching done on them. The western occurrence shows iron pyrites, blende, and galena, in a green lode-matter resulting from the alteration of the felspar-porphyry, which is here schistose.

South-east of this occurrence is a somewhat similar one. The trench shows a greenish quartzose lode, of which the bearing is about N. 35° W. The lode carries galena, blende, and pyrites. The country is the massive type of felspar porphyry.

The lodes on this section are well worth further prospecting, especially the eastern one, which I think to be probably the southward continuation of the "main lode" on Thomas' Blocks. The prospecting now being carried out on the latter property will no doubt afford valuable information, which will be of benefit to the future prospecting of this lode. The surface configuration will enable the lode to be worked at several levels by means of short adits.

(15)—THE SECTIONS IN THE STERLING RIVER VALLEY.

To the west of the Thomas' Blocks and Donoghue's sections are a line of sections situated on the low ground leading down to the Sterling River. These sections—numbered 2861-M, 20 acres; 2837-M, 80 acres; and 2862-M, 68 acres—stand in the names of J. H. Finlay and M. Donoghue.

The western portion of the area consists mainly of slate, but in which there are some parallel narrow bands of porphyroid. The outcrops are few, and I could not determine whether the porphyroid was intrusive or whether thin sheets of lava were interbedded with the slates.

There is a long quartz reef traceable right through these sections from end to end, which has a trend slightly to the east of north.

The only work done on these sections has been carried out on this quartz body.

The outcrop of quartz has been cut through by a trench at a point just south of the boundary-line, between Sections 2837 and 2862. The quartz is some 15 feet across at this point, and has a westerly dip. There is a little iron pyrites present in the quartz, and with it some copper pyrites. On the hanging-wall side of the reef in the slate there is a vein of galena half an inch in width; and on the footwall side there is a gossanous admixture of quartz limonite and iron carbonate carrying a little galena.

An assay of the ore from this spot is said to have shown the presence of 11 ozs. of silver to the ton.

A few chains to the northward the quartz shows only iron pyrites, and no trace of lead ore.

Following the outcrop northward it disappears under the button-grass, but again reappears in the same line. Some trenches have been cut across it in Section 2861, and just outside the northern boundary of this section, but only iron pyrites was found in the quartz.

of it remaining. It is said that the black gossanous material on the border of the mass contains native copper. No specimen which I examined carried the mineral. The country rock is porphyroid.

All the ironstone seen was apparently well above the water-level, and the workings are consequently too shallow to give an idea of the proportion of copper ore associated with the hematite. The configuration of the country is rather unfavourable for the driving of a lower-level tunnel. It would be better in future prospecting to sink on the lode.

On the southern section the porphyroid carries a few stains of copper carbonate, but outcrops of the rock are few, and no further signs of the presence of a lode were detected.

(*c*)—*The Barytes Lode.*

Situated between Section 2865 and the Murchison River, and at a height of from 600 to 700 feet above the river, there is a strong vein of barytes.

This is exposed at the surface for a length of 5 chains. Its width is at least 4 feet at the southern end of the outcrop, but no work has been done elsewhere, and I cannot say if this is the average width.

The barytes is crystalline, and white or transparent at first sight. Careful examination, however, shows that it is flecked throughout with minute specks of galena.

Several prospectors enquired of me whether the barytes cap might not be a sign of a massive galena lode in depth. They seemed to have the impression that there were known cases of the variation of lode contents of the type mentioned. If any such cases exist they are unknown to me.

It is true that in the case of barytic lead-veins* the progress of weathering may after a long interval of time produce a gossan relatively rich in barytes. This is because of the insolubility of barytes. But in the present case the vein is a solid one, consisting almost entirely of massive barytes, and not a honeycombed gossan; and there is no justification for the belief that the mineral character will alter materially.

If the occurrence is to prove of commercial value it will be as a source of the mineral barytes itself. Barytes is used mainly in the manufacture of paint as a substitute for white lead or zinc oxide, and to a less degree for weighting paper and for the preparation of the oxide of barium.

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* Described on p. 49 of this report.

For such purposes it is necessary to, first of all, free the barytes from its associated impurities. In this case no great difficulty would be encountered; for, apart from the small galena content, I did not observe any other mineral present, and the purity of the colour indicates its freedom from iron.

The price fluctuates slightly, but the average value for the crude product, delivered at a grinding-mill, may be reckoned at between 16 and 20 shillings per short ton.

When finished for the market, the mineral is worth as much as £4 per ton.

Until better facilities for the transport are available, I doubt if the value of the mineral is sufficient to justify the exploitation of the lode.

(18)—THE EASTERN SECTIONS ON THE MURCHISON RIVER.

(*a*)—*The Sections known as "The Osborne Copper Blocks."*

The track which follows the northern bank of the Murchison River towards the south-east traverses a number of sections, of which only two are at present taken up. These are Nos. 2144-M, 80 acres; and 2145-M, 80 acres—both of which stand in the name of C. Madden. The greater portion of both these sections consists at the surface of chloritized quartz felsite, but the conglomerate encroaches upon the borders of each section.

On the northern side of the river, near the centre of Section 2144, there is a massive outcrop of hematite. The schistose green quartz felsite has been, by silicification, converted into a grey quartzite in the immediate neighbourhood of the hematite.

A few distinct quartz veins are to be seen, and these carry both iron and copper pyrites; and besides these actual veins, the green quartz-felsite is irregularly impregnated with iron and copper pyrites and a little galena. Very little prospecting has been done on this outcrop, which certainly merits further attention. Two approaches of a few yards each have been cut from the west and north-west, as if to cut the hematite body; but in neither case has the work been carried far enough to afford much information.

Below this point, on the track, the quartz felsite again shows an impregnation with copper pyrites.

This section seems well worthy of more work being carried out upon it. Very little has ever been attempted, and the vegetation is so thick that prospecting cannot be carried out without trenching.

In the adjoining section (2145) at the southern corner of the portion which lies on the northern side of the Murchison River, and right on the water's edge, there is a further outcrop of metal. A zone of the quartz felsite about 30 feet in width is impregnated with copper pyrites and bornite. The occurrence has had very little done on it, and the surface only has been exposed here and there. As far as I could see, there are no definite walls to the deposit. Some joint-planes are visible, but these seem of later date than the impregnation with metal, for the ore does not follow the divisional planes at all.

This formation should certainly be vigorously prospected.

A very similar occurrence of quartz felsite which has been impregnated with copper pyrites is situated nearly a mile south of this spot, on Section 4440, where the track traverses the centre of the section. Here, too, only the surface has been broken from the outcrop.

On the southern side of the river, and in Section 2145, some further workings are situated. Some copper and iron pyrites are visible in the quartz felsite, and a short tunnel has been driven westwards at a point 75 feet above the river. The tunnel only runs in some 15 feet; and a short drive, 10 feet in length, runs southwards from the end.

About 20 feet higher up the hill the quartz felsite is replaced by actinolite rock. A trench shows a few colours of iron pyrites and hematite along joint-planes, and in thin seams in the rock. The prospects at this point do not seem very encouraging.

(*b*)—*Foy's Lode.*

During my visit to the field a discovery was made by R. Foy of a lode crossing the Murchison River in the north-western corner of Section No. 24-M.

There are two distinct veins on the eastern side of the river, separated by a distance of 5 feet. The eastern one carries some good coarse galena associated with blende, iron pyrites, and copper pyrites in a gangue, which is mainly silica. A few fragments of bleached and kaolinized country rock are included in the lode. This vein is about 8 inches wide where it was first picked up, at a height of 25 feet above the river, and widens to a foot or more at the water's edge.

The eastern wall (footwall) is the green quartz-felsite which has been sericitized. The hanging-wall is impregnated with very finely divided galena and thin veinlets of quartz and pyrites. The dip is towards the west, at about 75°; and the strike, measured across the river to the outcrop on the other side, is N. 21° W.

The western vein is smaller—4 inches wide—and dips to the west at angles which vary a good deal over the small length of lode visible. It carries a little less metal and more quartz. Blende and copper pyrites are present with the galena. Across the river at the water's edge both veins could be seen; but they are here hard and quartzose. The two veins unite about 12 feet from the water, and at the junction a pocket of good galena occurs. A little blende, copper pyrites, and fahl-ore accompany the galena at this point.

Traced beyond the intersection the ore becomes once more hard and dense, and narrows down to a width of 6 inches.

The pinching of the lode may be only a local feature, but the prospectors will probably find it more profitable to exploit, first of all, the main vein on the eastern bank of the river. As a preliminary to future operations, I should advise trenching on the eastern bank.

The lode being known to persist on the western bank, it should be eventually followed there; and the exploitation at this point will be easy, since the bank rises almost precipitously from the river.

The brecciated character of the lode-stuff indicates the fact that the lode is the result of the filling of a well-defined fissure, rather than an impregnation of the country rock.

(c)—*Kittson's Workings.*

Following the track southwards from Foy's lode a small outcrop of hematite is met at a point just outside the western boundary-line of Section 24-M. The country rock is quartz felsite, but no copper is found here in association with the iron.

The track follows the river bank, and no striking difference is noticeable between the country rock here and that further north until a belt of crushed conglomerate is met with, similar to that which forms the western slopes of Little Farrell, in Section 2911.

Beyond this the igneous rocks occur again, and in them the old workings of H. E. Kittson are situated. The section, No. 2829-M, 80 acres, is now registered in the name of L. Jolly.

The workings are in the northern portion of the section, and on the south side of the river close to the cage.

Close to the landing-place of the cage, and only just above the river level, an excavation has been made in the steep bank, which shows a band of quartz porphyry impregnated with iron pyrites, copper pyrites, native bismuth, and a complex mineral termed lillianite. Some oxidised copper ores are also present. Some very rich silver ores are said to have been derived from this locality; but in what form the silver existed I cannot say. The veins seemed to run in all directions, and all the mineral exposed was much weathered and discoloured by limonite.

About 150 feet to the south-east, and 80 feet above the river, another zone is opened up, some 20 feet wide, and through it a number of small veins run. The veins are vertical, but their strike is very variable. These veins carry a little iron and copper pyrites, together with some specular iron ore.

Below this outcrop, and 30 feet above the river, a tunnel was started in granite, but abandoned when 15 feet of driving had been done.

The mouth of the tunnel shows a greenish altered zone in the granite, which appears to dip northwards. If the work is persevered with, this tunnel should prove the lode-formation in depth. The surface workings are too much affected by weathering to give much information at the present time. I could find no sign on the surface of a main fissure, nor could I trace any connection between the ore exposed in the two sets of workings.

No work at all was being done at the time of my visit to the locality, and there were no signs of any recent attempt to prove the property.

(19)—THE SECTIONS ON THE PIEMAN RIVER.

The track to Rosebery from Mt. Farrell follows the Pieman River round the base of Mt. Black, and from the Murchison River on the western side of the Mt. Farrell township to the railway bridge over the Pieman the country rock traversed is wholly the felspar porphyry.

The river alluvial overlaps the base of the higher ground, and the present river has cut its way down through this gravel.

The felspar porphyry is very similar in appearance to the corresponding rocks further east. It is on the whole schistose, but the degree of schistosity varies between wide limits.

The region is traversed by a number of minor, and one major, fractures, at a distance of about 2½ miles from the junction of the Mackintosh and Murchison Rivers.

Only one section on the area is at present taken up, viz., No. 2382, 40 acres, which is registered in the names of G. A. Gabbedy and W. M. Black. It is on this property that the mine known as the Langdon is situated.

The lode was first discovered at the point where Innes' track crosses it by a prospecting party, who worked northwards from Rosebery along the felspar porphyry belt. It exhibits a marked peculiarity of structure, in that the strike is due east-and-west. The dip is northward.

A tunnel has been driven southwards from a point 30 feet below the outcrop. The bearing is 147°, and at 30 feet it passed through the lode.

It is said to have been driven another 30 feet on the same bearing, but the portion of the drive past the lode was blocked by waste. The tunnel was carried past the lode, for the reason that the values had so materially decreased in depth that it was thought the lode was still ahead.

I am informed that the upper portion of the workings produced some very good galena, of which about 40 tons was taken to the smelters. At the time of my visit all this material had been stoped out right to the surface. A few specimens lying on the tip showed good coarse galena with resinous-looking blende.

There is a drive on the lode from the adit for 30 feet in an easterly direction. The back of the drive shows that the ore-body has pinched to a width of only a few inches, and, in fact, can hardly be traced at the intersection of the drive and tunnel. About 10 feet from the end of the drive there are 6 inches of ore, consisting of coarse galena mingled with resin blende. But on the whole the galena seems to have given place to resin and ruby blende.

The contraction of the ore-body and the impoverishment in the lead content have no doubt led to the abandonment of active work, and the mine has been idle for 12 months.

It is regrettable that while work was in progress no winze was put down on the lode to prospect it in depth. The pinching of the lode may be only a local feature, and after such a promising outcrop it is a pity not to carry the work down beyond the very shallow-level tunnel.

There have been several trenches cut on the western continuation of the lode outcrop, but they show only zinc-blende with traces of galena in veins through a mineralized zone. These trenches extend to the western boundary of the section, and have not indicated sufficient values to justify further prospecting at a depth.

The country rock is a felspar porphyry, which is slightly altered near the lodes, probably by the development of sericite. Numerous veinlets of silica are to be seen in the country rock near the lode, and these veinlets seem to have a tendency to run in an east-and-west direction. The country rock is also indurated here and there by an intimate impregnation by silica, till it resembles a chert.

Higher up the hillside, some 250 feet along the track, there is a little work done on a gossanous capping. A few shots have been put in, and a complex lode-formation is disclosed. It is 6 or 7 feet in width, and carries a number of small veins up to 3 inches in width of zinc-blende, and very occasional splashes of galena. The blende has by weathering acquired a coating of limonite, but the undecomposed material is dull yellow, and has been mistaken for carbonate of iron.

Too little of the lode was exposed to determine the dip. The strike seemed to be a little north of east. The country rock is similar to that of the Langdon Mine.

There has been some trenching on the adjoining section, 2524, now vacant.

In one of the trenches below the track on the eastern boundary a small vein, some 4 to 6 inches in width, is exposed. It strikes N. 55° W., and dips to the north-east at from 80° to 85°. The lode contents are blende and a little galena in a band of silicified felspar porphyry.

A trench running a little east of north has been put down to cut the continuation of this lode, but without success.

There is also some trenching on the line of the Langdon lode, and in one trench a lode a foot wide, carrying some veins of tarnished blende and a little galena, is visible. A winze, full of water at the time of my visit, had been put down in the bottom of the trench, so I could not see the lode at that point.

The veins that have been located in this section seem to carry blende rather than galena, and work in the area has been altogether abandoned.

VII.—CONCLUSION.

Summing up, the writer may express the opinion that there is a well-assured future before the central area of the Mt. Farrell mining field.

The centre of future operations will, as far as can yet be foretold, be located round the North Mt. Farrell and Mackintosh leases. These appear to possess, in a greater measure than any others, the attributes which justify the outlay of capital for the development of the mines and the treatment of the ore.

One of these properties—the Mackintosh—is at present practically untouched. Yet the ore proved at the surface gives every indication of permanency in depth, and the length of the lode compares favourably with that of the lodes on any other lease in the field.

The ore-bodies on the two above mentioned properties contain a bulk of second-grade ore, which will, with efficient milling plants, ensure profitable returns for several years at least.

And there are several other properties to the southward which can show a fair amount of milling ore. No one of these, taken by itself, can yet be said to have justified the erection of a concentrating mill. Still, were a customs mill located in the district, there are several mines, now inactive, which would probably contribute second-class ore. The returns from this second-class ore would at all events assist financially towards the development of the properties; and during the mining of the second-class ore the contributing mines might well improve, or show an ever-increasing bulk of the milling ore.

The tendency has been thus far for the management of those mines which are in the earlier stages of development to expect highly payable lodes of first-class ore, rather than lodes of which the greater proportion, at least, is second-class ore. This being so, the work of development has in some cases been abandoned at once where first-class metal is not encountered. The lessons taught by the development of the North Mt. Farrell Mine should be remembered; for not only does the ore-body vary very considerably from point to point, but in one case the main lode (No. 3 lode) was passed through without being recognised.

The attitude assumed with regard to the presence of first-class ore has resulted in undue prominence being given to the assay returns from picked specimens of ore. Few, if any, assays of samples properly taken are obtainable; and the value of assays of specimens is, of course, purely qualitative. The presence of fahl-ore with the galena, will, in the majority of cases, ensure a high return of silver. Yet, in the mines which have been opened up to any extent, the proportion of fahl-ore to galena is small.

The recent developments at the southern end of the field seem to point to its presence in larger proportions there, but this cannot be regarded as certain until the lodes are opened up more extensively.

The southern end of the field is undoubtedly expanding, and much will depend upon the work of the next few months on the Tullah Mine and Thomas' Blocks. Every successful development on these properties will stimulate further prospecting in this direction.

The northern end of the field has been seriously hampered by the difficulties of transport, and the lodes which have been located are almost entirely undeveloped, notwithstanding the fact that they were the first discovered in the district.

There is one strip of country which has thus far quite escaped the attention of prospectors—that between the Tullibardine lease and the Farrell Blocks, and lying on the western side of the Mackintosh River. It has been indicated in this report that it is probable that the Tullibardine lode lies on the main fracture-line of the central and northern part of the field, the strike-line of which has been bent a little to the eastward by the disturbance which produced the fault that traverses Section No. 2796.

The area on the Murchison River, eastward of the gorge cut through Mt. Farrell, is well worthy of more systematic prospecting. The recent discovery of a lead lode in that district should assist in stimulating prospecting activity.

This report embodies the field work which was carried out during the months of September, October, and November of 1907.

In conclusion, I wish to express my appreciation of the assistance afforded to me during my examination of the field and the preparation of this report by all those who are, in different capacities, interested in the field. The number of these to whom I am indebted is so large that I trust I may be permitted to make this general acknowledgment of thanks.

L. K. WARD,
Assistant Government Geologist.

Launceston, 15th February, 1908.

KEY TO PLATE II.

The Mineral Sections now taken up.

Number of Section.	Acres.	Lessee.
White Hawk District.		
2330-M	42	R. P. Symmons. (The White Hawk.)
2331-M	80	
2332-M	47	
3367-M	72	R. P. Symmons and C. R. Lynch.
3368-M	40	
3369-M	37	
The Area North of Mt. Farrell.		
2592-M	80	J. McPhee. (The Tullibardine.)
2593-M	80	
2058-M	80	
The Area on the Western Slopes of Mt. Farrell.		
2873-M	80	C. R. Lynch.
2892-M	40	G. E. Butler.
2796-M	80	G. E. Butler. (Formerly Metropolitan.)
2909-M	80	W. Innes.
2905-M	80	J. Geddes.
2397-M	79	E. Goldsmith. (Farrell Blocks.)
2820-M	80	A. E. Goldsmith.
2983-M	80	A. E. Goldsmith.
3010-M	80	D. Powell.
3223-93M	80	Macintosh Copper & Gold Mining Co., N.L
3221-93M	80	
4116-93M	68	North Mt. Farrell Mining Co., N.L.
3262-93M	76	
1867-93M	80	
2351-M	75	
2722-M	40	
1074-M	20	
292-W	10	
82-W	4	
2409-93M	80	Mt. Farrell Mining Co., N.L.
2410-93M	80	
2656-M	10	
2815-M	80	M. L. Maconnochie.
1980-M	80	(Formerly Central Farrell.) Murchison River Mining Association, N.L.
3263-93M	60	
1286-M	5	
1075-M	79	E. T. Midwood (Murchison Extended). (Formerly North Murchison.)
2777-M	80	H. J. Kelly.

Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 4

THE LISLE GOLDFIELD

BY

W. H. TWELVETREES
Government Geologist

Issued under the authority of the Hon. [illegible], Minister for Mines

Hobart:
John Vail, Government Printer

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CONTENTS.

PAGE

I.—INTRODUCTION 5

II.—PREVIOUS LITERATURE 6

III.—PHYSIOGRAPHY 10

IV.—GEOLOGY 12

V.—HISTORY 20

VI.—MINING 22

VII.—DERIVATION OF THE GOLD 29

VIII.—COUNTRY NORTH OF LISLE 32

IX.—COUNTRY SOUTH OF LISLE 34

X.—APPENDIX ON THE DETERMINATION OF HEIGHTS ... 37

PLATES.

1. Geological Map of Country near Lisle ... ... At back
2. Geological Map of the Lisle Goldfield ... ... At back
3. Geological Section of the Lisle Valley ... ... At back
4. Photograph of the Lisle Valley ... . At front
5. Photograph of the Lisle Valley ... ... At front

LISLE VALLEY. [*Twelvetrees.*

LISLE VALLEY. [*Twelvetrees.*

THE LISLE GOLDFIELD.

[Five Plates.]

I.—INTRODUCTION.

THE small township of Lisle is situate by road 7 miles south-west of the Lisle-road station on the Launceston to Scottsdale railway, and 8 miles due north from Patersonia. Cart traffic is mostly by way of Lisle-road, but the mail-horse route is *viâ* Patersonia. The few homesteads and surviving cottages are on the floor and basal slopes of a broad valley, about 2 miles in length, running in a north and south direction, and forming a triangular or sub-elliptical area between the Main and Bessell's Creeks. The confluence of these two creeks takes place at the northern end of the valley, where the hills close and a rocky gorge is formed through which the Lisle Creek flows northward to join the Little Forester River.

About a couple of dozen men are now occupied in sluicing the gravels for gold. The sawmill, which supplies timber for the builders' use in town, gives employment to several men. These, with the inhabitants of a few homesteads, make up the present population of the valley. Scrub has grown up again on the flat land which many years ago was cleared when mining was in full swing in the valley. Some of the purchased land in the centre of the valley and on the eastern slopes is cleared, but the rest is closely timbered for the most part. Tall gum forest clothes the hill sides, with a thick undergrowth of dogwood, musk, and cathead fern. The soil in the valley and on the lower slopes is clayey with a granitic bottom, and the land is well suited for grazing purposes. Fruit also does well. Mr. Furlonge has an orchard which produces apples admired in the London market.

The goldfield and the land surrounding it have been withdrawn from selection for many years, but 1400 acres in the south-western portion of the reserve have recently been proclaimed available for purchase, though in deference to indications of renewed mining activity on the field no sales have as yet been sanctioned.

II.—PREVIOUS LITERATURE.

The Government has caused two official examinations of the Lisle field to be made previously to the present one. The first report was by Mr. G. Thureau, Geologist to the Government of Tasmania, and was published as a House of Assembly Paper (No. 46), in 1882. The following extract will serve to show the conclusions then arrived at:—

"At the junction of the metamorphic schists with the syenitic granites, not only are there narrow quartz veins accompanied by granitoid vein matter, mica, hornblende, &c., but distinct, though small, veins of this granitoid rock protrude and traverse the schists for a considerable distance from the main body . . . .

"Bearing in mind that the whole of the granitoid formations are traversed by attenuated quartz veins charged with very fine gold, it may be inferred that if any vein matrices with coarse gold exist the probability is that they occur at or near the points of contact of the granitoid with the metamorphic or other schists on the Lisle Divide and in the eastern foothills of Mt. Arthur."

The second Government inspection was by Mr. A. Montgomery, M.A., who reported on certain portions of the Lisle goldfield, on 13th September, 1894. This report was not printed. The following is extracted from it:—

"The Lisle workings lie in a somewhat wide valley, which contracts to a gorge lower down the creek. The bottom of the valley has been worked for some 500 or 600 feet in width, from which it would appear that the auriferous material could not have been confined to one narrow lead, but must have spread over some distance. Round the edges of the flatter ground at the foot of the slopes of the surrounding hills there are large terraces of alluvial material, some of which has been successfully worked. It seems rather likely that at one time the detritus from the surrounding slopes was brought down into the flat part of the valley faster than it could be discharged through the gorge at the outlet, and consequently large accumulations took place, especially at the bottom of the hill slopes. In one claim I noticed traces of the former presence of still water, there being a layer of finely laminated clay and sand lying horizontally upon the bottom gravel, and in the clay were numerous lignitic impressions of leaves . . . The gold from this field is very fine in grain, nuggets being quite rare, and is said to be very seldom found with quartz attached to it. The wash is of a clayey nature in the terraces, with not a great deal of stone through it. The stones are but little waterworn, and consist of metamorphic sandstones from the surrounding hills, chalcedony from veins in the granite, and only a little quartz that seems likely to have been derived from reefs. In parts we find veins and patches of quartz wash, but on the whole it does not seem very plentiful. In some of the claims towards the head of the valley there is much less clay than in the terraces near the township, and faces of 6 to 15 feet in depth of coarse sandstone gravel are seen in the workings. In these the stones are more waterworn, and the wash appears to be richer in gold. . . . The veins on Titmus and Dodgshun's sections are said by some to be the only ones yet found carrying gold on the Lisle field, but I have also been informed that similar ones were not infrequently met with in the bedrock by the alluvial diggers. It seems very possible that much of the gold in the valley has been derived from similar veins, but I am more inclined to think that the sandstone country, and particularly the belt along the contact between the granite and the sandstone, will in time prove to be the source of the gold."

Mr. Charles Bessell (the Bessell Bros. were the discoverers of Lisle) wrote a report for a proposed hydraulic company in 1894, and the following extracts are taken from it:—

"Payable Ground Available.—This, I may say, is practically unlimited. In my opinion there are three distinct deposits of gold in the field, and it is also my opinion the sources are all within the Lisle valley, and have yet to be found. However, I can, I think, safely state that there are 500 acres averaging 12 feet in depth. This ground may be equally divided into old ground or ground that has been worked in the early days, and new or sound ground; part of this is not rich enough to pay by the slow process of pick and shovel. As to the old ground, in my opinion this would pay well, for personally I prefer to work good old ground than new poor ground. As to the probable yield per cubic yard, this is rather a difficult question to deal with, as in some places the gold is distributed through the ground from the surface to the bottom, while in others it is confined to the wash on the bottom, which varies from 1 foot to 5 or 6 feet. I have worked ground here with a payable prospect from the surface to the bottom 15 feet in depth. I have also worked ground the same depth with no gold except in the bottom 2 feet with equally payable results. However, I believe I shall be well within the mark if I say the whole of the ground referred to will average from 4 to 6 grs. to the cubic yard—this is independent of rich patches, which will probably go several pennyweights to the yard, and I feel quite confident that many of these will be met with as work proceeds. I may state that there are many indications of false bottoms existing on the terraces; in fact, Cashman and party are at present working under 2 feet of false bottom, and again, it can be seen where I am now working at the camp, but how far it extends into the hill has to be proved. With reference to the quantity of gold obtained here I have heard many estimates, but being connected with its discovery 15 years ago, and having an object in endeavouring to ascertain the yield for the first years, as the Government of the day offered great inducement to prospectors in the shape of a large reward for the discovery of a payable goldfield, during the first year I obtained certificates from some of the gold-buyers that they had bought about 15,000 ozs. This, however, does not represent the total yield, and I have heard that Mr. Bernard Shaw, who was then Commissioner of Mines, estimated that not one-third of the gold won was sold in the country. In this I quite agree with him, as a very large number of the 2500 miners then on the field came from Victoria, and I know many of them took the gold there periodically. It must also be remembered that during the first year the men had all their dead work to do in opening up their claims, consequently were not getting gold the whole time, and one of the buyers referred to told me he had bought more gold the first half of the third year than he did during the whole of the first year. Taking all this into consideration, I believe I shall be near the mark by estimating the total yield to be 250,000 ozs., or in round numbers £1,000,000 worth; but I have heard some estimate the yield to be considerably over that amount. With reference to the yield of individual claims, this is a difficult matter to get at, as miners are generally very reticient on this subject. However, I have heard the yield of some of the claims from reliable authority. The best yield I have heard of was from Clare Brothers, who obtained over 1000 ozs. from two men's ground. This claim was on Bessell's Creek, and may be taken as an average. Donnelly and party, I am told, got considerably over 1000 ozs. from their claim. There were several good claims on the terraces, the wash-dirt varying in thickness from 1 foot to 4 feet., and yielding from 5 dwts. to over an ounce to the load. The first claim in which I was interested yielded nearly 500 ozs. from four men's ground. This claim was on Bessell's Creek*, and may be taken as an average of all the claims on it for a distance of nearly 2 miles in length. Shillady and party have, I believe, won over 2000 ozs. from their claims. Cashman and party are reported to have had very good results all through, and I am informed that the last six months' washing resulted in nearly £200 per man."

In 1899 the Lisle Dredging Company was formed to work the deposits in the Main Creek, and published some reports with its prospectus. One of these reports was by Mr. Thomas Kelly, who has worked on the field for many years, and the following is a copy of same, omitting purely commercial references:—

"I here submit my 20 years' practical knowledge of the field. The ground held by your syndicate is known as the Main Creek, embracing some 2 miles of the same; also some terrace ground at the head of the creek which is supposed to be the source of the shed of the gold into the valley of the Lisle. I have not the slightest doubt of the 2 miles of creek being payable; that is, by treating it on a large scale. There have been several syndicates formed, and the required capital subscribed, to work this same ground. They estimated that the tail-race would cost £5000, but when levels were taken they could not obtain sufficient fall to sluice the washaway. In my opinion the only way the ground can be treated is by dredging it. The richest of the veins were on the course of this Main Creek, and therefore wet claims to work, and when they are wet there is always a loss of gold. For instance, myself and party worked ground known as Donnelly and party's. We worked the claim out for a yield of over 2000 ozs. It being situated on the terrace we brought water on to it, and it was ground-sluiced away for a return of over 700 ozs. of gold; that made the yield of gold from four men's ground over 3000 ozs. As to the probable loss of gold in the Main Creek, there is no doubt they were mostly all rich claims, and I can safely put the loss down at one half of the return we obtained by ground-sluicing Donnelly and party's claim, say, 350 ozs.

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* The present Main Creek used to be called Bessell's Creek.

to the acre. Your syndicate holds, say, 2 miles of the creek, and without a doubt there must be in the old ground alone, to say nothing of the solid blocks that have not been worked, some thousands of ounces of gold, as the diggers in the early days looked for 2 or 3 grains to the dish, and anything less was thrown away. Regarding the upper portion of your ground—that is what is known as the deep ground, which is supposed by many practical miners to contain the source of the gold which was worked in the Main Creek—there have been many parties formed to test it, but owing to the ground being too deep and wet they had to abandon it, so I cannot say much about it, only that the ground was payable up to it. This field was the richest alluvial field opened in Tasmania; the yield of gold settles that point. The return from here is roughly estimated at 300,000 ozs., and the greatest portion of it was obtained in the main creek and terraces on each side of the creek. The dirt is of a friable nature, easily treated; and the bottom is a decomposed or soft granite. The water the creek carries in the summer season is about 4 sluiceheads, in the winter months from 20 to 25 heads."

III.—PHYSIOGRAPHY.

Enclosed by high hills, Lisle is an upland valley, the floor of which is from a mile to a mile and a half in width. Its approximate height, according to aneroid readings, is between 700 and 800 feet above sea-level. The railway-station at Lisle-road is 341 feet above the sea, so that the Lisle township is about 400 feet above the railway line. For notes on the determination of heights, see appendix to this report.

The crests of the hill ranges on either side of the valley are about 3 miles apart east to west, and the valley is closed in at its head to the south by a broad divide 1200 feet above the township. On the southern side of this divide is the fall to the Scottsdale-road, and a couple of miles south-easterly the high land rises to the summit of Mt. Arthur, formerly called Row Tor, 3895 feet above sea-level. The two sides of the horseshoe thus formed flank the Lisle Valley as high narrow ridges, 800 to 1000 feet above the township. The eastern ridge separates the Lisle Valley from the deep basin of the Little Forester River, and the western ridge overlooks on the west the valley of the Lone Star Creek, and the head of the eastern branch of the Denison River.

The configuration of the valley shows that its age is considerable. The flat floor has been gradually widened and the steep sides pushed further and further apart. The north-easterly dip of the strata has contributed powerfully to the downward creep of the hill debris, which everywhere thickly covers the surface of the bed-rock and accumulates towards the foot of the hills on the east side of the basin in large terraces of angular stones. On the west side the terraces are not so numerous, owing to the different conditions caused by the dip there. The Main Creek hugs the base of the range on the eastern side, and Bessell's Creek does the same on the western side. Stony Creek and Thomas' Creek, which flow down from the western mountains, add to the volume of water carried off through the gorge. The ground is flat, and possibly at one time the rainfall was such that there was more water than could get away easily through the narrow outlet at the gorge. At present, notwithstanding the steep grade of the hills, floods are not complained of, and though the encircling ranges are chiefly narrow divides with small catchment areas, the rainfall as a rule is sufficient, though last summer, as elsewhere, was dry. There is no meteorological station here. The nearest are Scottsdale and Patersonia. The rainfall at Scottsdale, from 1st October, 1906, to 30th September, 1907, was 47.25 inches on 155 wet days. At Lisle it is probably in the nighbourhood of 40 inches. The clouds often pass over, following the mountain crests. Although, owing to the high hills surrounding Lisle, the winters are cold, the climate is milder than that prevailing on the south side of the divide, where the influence of Mt. Arthur and Mt. Barrow is more distinctly felt. Snow falls in the valley very seldom.

The prospector for reefs experiences great difficulty from the heavy overburden of surface debris which has slowly accumulated on the mountain slopes. I was shown one place up the hill where the granite bed-rock had been exposed in 3 feet of sinking, but a few chains away no bottom had been reached in 70 feet. This gradual uninterrupted process of accumulation interposes a serious bar to costeaning. That reefs of some sort are present in these hills is evident from the profusion of stones of quartz present in the terraces, which have been worked by the miners, and here and there barren veins are known, but the reefs which have shed the bulk of the unproductive stone found in the workings have not been uncovered owing to the thickness of loose stony débris or clayey soil covering the surface.

The main reefing lines in the sandstone strata are likely to run more or less parallel with the north-westerly strike of the strata, consequently, roughly parallel with the long axis of the valley. The little creeks which flow into the Main Creek from the eastern side of the valley run over the granite zone, taking their rise for the most part near the junction of the granite and sandstone. Hence their value for intersecting reefs in the sandstone country is nil.

IV.—GEOLOGY.

The rocks which occur in the district fall into the two divisions of eruptives and sedimentaries.

(1.)—The Eruptive Rocks.

There are three groups or varieties of these, viz., granite, diabase, and basalt. Of these, the granite is the most important in every way, as the diabase and basalt have never been found in Tasmania to bear any relation to the process of deposition of the more valuable metalliferous ores or metals.

A.—*The Granite of the Lisle Valley.*

Below the alluvial of the creeks and the surface deposit of clay which covers the valley plain is the granite bedrock. This is very generally concealed by the waste from the hills, but undoubtedly forms the solid floor of the valley and rises up the flanks of the mountains to a height of between 400 and 500 feet, when it junctions with Ordovician sandstone and slate. The exact line of the junction is hidden by the hill waste, but it is roughly traceable on the eastern side by the top of the granite forming a fringing shelf from which the sedimentary strata rise at a steeper angle of slope. The granite rises towards the south till it attains a height of about 700 feet, when it apparently passes under the divide in a south-easterly direction, reappearing, I am told, on one of Millwood's sections, and certainly exposed again beyond St. Patrick's River at Diddleum. The same belt comes to view again in Lone Star Creek and at Panama.

In the Lisle workings the granite is soft and decayed. At three places in the lower part of Main Creek loose boulders of the hard unaltered rock are seen in positions which indicate the rising to surface of the solid granite mass. The rock itself is not dyke rock, but the normal granite of the belt. Higher up, at the head of the valley, on W. Kerr's land, is a knob of hard granite of the same type. At the north end of the valley, at the gorge, the granite sinks to the level of the creek, and disappears below the micaceous sandstone which forms the hill to the west.

To the naked eye it is of a finer grain than the familiar granite of the North-East Coast, and has a characteristic appearance, owing to dark magnesian mica (biotite) with some hornblende being present in great abundance. Quartz, though present, is subordinate. The type is the well known one of hornblende granitite. Rosenbusch defines granitite as follows:—*

"It is distinguished from granite, not only by the absence of muscovite, but is nearly always richer in lime-soda felspars, coloured constituents, and iron oxides, though on the other hand poorer in quartz than granite proper, in the restricted sense of the word . . . . The normal type of granitite takes up hornblende readily, and in this way the variety of hornblende granitite is formed (in petrographical literature often called syenite-granite)."

This rather basic, or, more strictly speaking, less acid variety of granite appears to be characteristically associated with gold rather than tin ore. The same type prevails all along the gold belt, at Diddleum, Lisle, Golconda, and where it is dominant it is safe to say that gold, and not tin, will be the metal that should be sought, as far as this part of the island is concerned. This is not affected by the circumstance that a little tin has been reported as found with the gold at Lisle.

B.—*Diabase.*

On the south divide, on T. Faulkner's (now A. Dean) 100 acres purchased land, and about 5 chains south of the north boundary, is a line of boulders indicating an outcrop of this rock running towards the west. It is the same rock as that which forms the summit of Mt. Arthur, consisting of a mixture of felspar and augite. The felspar is labradorite. The rock is of medium texture. It is too well known to need here a recapitulation of its microscopic characters. It intruded in the older sandstones and the overlying Permo-Carboniferous strata, which latter have since been denuded, resulting in the exposure of the intrusive rock. Its age is approximately that of the close of the Mesozoic, consequently younger than the granite and older than the basalt. It is not connected in any way with the deposition of ore, and the only use apparently to which it can be put is in making foundations for buildings and bridges and metalling roads. For the former, it is strong and durable, but does not dress easily; and for the latter purpose it is not quite an ideal stone, being too tough to powder sufficiently to supply its own binding, and rather hard for horses' feet.

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* Mikroskopische Physiographie der massigen Gesteine, 1907, I. pp. 61-62.

C.—*Basalt.*

In the eastern part of the preceding section and the one adjoining it on the south the rich soil of the farm land proclaims the presence of the basaltic lava sheet, 1800 feet above sea-level. This volcanic sheet is pretty well continuous to the south-east as far as and beyond St. Patrick's River, but it is often reduced to a thin covering of decayed rock or is even completely broken down into its characteristic soil. The ash cones of the Tertiary volcanoes have long since disappeared, and the former vents have not been located.

There are grounds for believing that in early Tertiary times the land in Northern Tasmania was even higher than it is now, but that a period of subsidence set in, which came to an end with the outpouring of the basalt lavas in the Middle Tertiary, since when an elevatory movement has taken place and the present Lisle Valley and gorge have been excavated.

The rock is the olivine-basalt, of which there appear to have been numerous outpourings in Tasmania at the close of the Lower Tertiary or Palaeogene period.

(2.)—THE SEDIMENTARY ROCKS.

(1.) These consist of slate and sandstone strata, which have a very regular strike of N. 30° W., and a north-easterly dip. They are traceable without interruption to south-east of St. Patrick's River, and the prolongation of their bearing in a north-westerly direction would approximately follow the course of the Little Piper River. The same strike and dip continue as far as to the west of the Piper River and Back Creek, but there is a change of dip to the south-west within a few miles of Lefroy. As a north-easterly dip prevails on the west side of the Tamar at Beaconsfield, that river is apparently either in a synclinal valley or, as is more probable, on the line of a fault which affects the older strata. In support of the latter theory is the negative fact of non-discovery on the east side of the river of any exposure of the Beaconsfield series.

The sandstone and slate strata form a belt on the east side of the Lisle Valley, while slate also skirts the west side. Another belt of slate comes in on the east on descending the range into the basin of the Little Forester. The sandstone and slate on the eastern ridge are metamorphosed to a hard, dark, bluish rock, with splintery and conchoidal fracture, and have been frequently mistaken for basalt. The rock has no doubt suffered from the granite contact. Where not altered, the sandstone is a soft brown micaceous rock. Another phase of alteration is also shown by the sandstone, which is slightly argillaceous, and under the microscope shows nodular segregations approaching the nature of incipient chiastolites.

Some obscure nodular forms are seen in sandstone to the west of the track on the top of the hill south of Lisle. It is rather doubtful whether these are organic.*

These stratified formations are with probable correctness placed in the Ordovician system. This conclusion is reached partly by the application of negative criteria and partly by connecting the stratigraphy with that of neighbouring belts of country. It has not been possible in Tasmania as yet to divide the Ordovician into Lower and Upper divisions.

(2.) Apart from the consolidated rocks is the heavy covering of hill débris and clay which clothes the hill slopes and is spread over the floor of the valley. This débris consists of angular and subangular stones of white quartz, sandstone, granite, chalcedony (from veins in the granite), and quartzite. The creeks contain waterworn stones of the same nature. There is some evidence of alluvial ground along the course of an older stream to the east of the present Main Creek on a higher parallel; † but there is no evidence of there ever having been any other drainage outlet to the valley than at the gorge end. There is a theory which is entertained by some on the field that a stream once passed north-west over or through the hill into the Lone Star Valley. I examined this divide, and came to the conclusion that no outlet could have existed in this direction. The dividing crest is solid sandstone, rising to 800 feet above the valley, and shows no indications of any alluvial covering which could mark a former channel.*

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* The earlier reference to graptolites, found at Lisle by Mr. Thureau, may be disregarded as based on a misapprehension.

† This was in all likelihood the ancient bed of the present Main Creek.

It is this unconsolidated mantle which has yielded all the gold which has been won from the field.

(2.)—*The Geological Sequence.*

This arranges itself as follows, reckoning from the earliest to the most recent places of the succession:—

(1) The deposition of the Ordovician sediments.
(2) The folding of these strata.
(3) The eruptions and consolidation of the granite.
(4) The period of the deposition of gold.
(5) The intrusion of the diabase.
(6) The outpouring of the basalt lava.
(7) Late Tertiary and recent sedimentation.

These periods cover the events which make up the geological history of Lisle so far as it can be deciphered from the rocks.

(1.)—*The Deposition of the Ordovician Sediments.*—This is the oldest geological process which we can here recognise. The more ancient rocks upon which these strata were laid down are nowhere exposed in the neighbourhood. The nearest reported occurrence of the older platform is near Glengarry, west of the Tamar, where crystalline mica schist indicates one of the Pre-Cambrian groups. The changes from sandstone to slate, and *vice versâ*, indicate frequent alternations of sediment from sand to clay when the Lisle beds were being formed.

The coast-line of this ancient sea is necessarily conjectural, but it may well have run along the Pre-Cambrian axis of what is now called the Asbestos Range, which stretches west of the Tamar all the way to Badger Head. How uncertain, nevertheless, such speculations are is exemplified by the microscopical examination of Ordovician slate at Mathinna, revealing, as it does, as constituents of the rock, minute fragments of granitic felspar, evidently derived from the waste of granite ranges long since vanished without leaving a trace behind.

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* The comparatively recent cutting of the channel through the Gorge leads one to search for another outlet, and a north-westerly one is the only other direction which is reasonable. If any convincing evidence could be obtained, one would have to resort to this supposition.

The Lisle belt of slate and sandstone continues south to the North Esk River (near which it encloses the Burns Creek reef), and beyond till it is interrupted by the Ben Lomond massif.

The Lefroy-Lisle Ordovicians differ in appearance from the Beaconsfield strata, which are perhaps somewhat older and do not seem to be represented to the east of the Tamar.

(2.)—*The Folding of the Ordovician Strata.*—The alternations of slate and sandstone in meridional belts and in directions parallel to the general laminations of the strata indicate that these partings as a rule conform with bedding-planes. Indications, however, are occasionally to be found showing the latter to be discordant and rather flat in places. These may be seen on the St. Patrick's River-road, past the post office, where the coarse partings of the slate, dipping steeply to the north-east, intersect almost horizontal bedding-lines. But whether the bedding is horizontal or inclined, the cleavage dips throughout are always at high angles. The change of dip between Lisle and the Tamar points to a great fold having occurred, and the anticlinal axis of this seems to be a little east of Lefroy. This is very likely responsible for the development of quartz reefs at that township.

The slaty cleavage is a regional feature, and results from the constituents of the original rock having been rearranged by earth-pressure. The period when this pressure was applied and the folding of the strata also took place has not been defined, but must have been between the close of the Ordovician and the beginning of the Permo-Carboniferous. As in other parts of the island rocks of Silurian age were involved in the process. The time was probably late Silurian or Devonian.

(3.)—*Irruption and Consolidation of the Granite.*—As has been remarked over and over again in our geological reports from Mr. A. Montgomery's time onwards, the granitic intrusions in Tasmania occurred between late Silurian and Permo-Carboniferous, and have generally been referred to the Devonian. Reference to this age will explain its presence in the Ordovician strata. It has invaded these in an axial line N.W.-S.E., through Panama and Golconda, Lisle, Diddleum, and so on, towards the North Esk. This line of outcrop lies several miles west of the large granite mass in the Scottsdale district, of which it is probably a differentiated marginal portion. The two outcrops are of different types of granite, but are doubtless connected in depth. It is to be noted that the main mass consists of granite of medium acidity, while the outlying Lisle-Golconda exposure is distinctly more basic.*

After the invasion of the ancient sediments by the granitic magma at an undetermined but great depth, the elevation of the land, throughout a long period resulted in the erosion and removal of the superincumbent strata, exposing the underlying granite. In some parts of the country, *e.g.*, on the Blue Tier, Ben Lomond, and in the St. Paul's Valley, the granite was exposed already in Permo-Carboniferous times, for sediments of that system are noticed reposing on the granitic platform. At Lisle the wearing down of the overlying strata to granite level apparently took longer time.

The intrusion of the granite produced profound effects upon the surrounding strata—effects which are noticeable to a distance of several hundred feet from the known contact line. The adjoining slate has been silicified, and a good deal of mica has been developed in it, with a production of incipient chiastolitisation. The sandstone, too, has been converted into a highly micaceous quartzite. These metamorphosed rocks form an aureole surrounding the intrusive granite mass. Their alteration has proceeded so far as to effectually mask their real nature and to deceive the casual observer as to their original character.

(4.)—*The Period of the Deposition of Gold.*—Under this head I do not refer to the redistribution of gold which has taken place in the present Lisle Valley, but to the deposition or precipitation of the metal in the veins or other sources which have supplied the alluvial or quasi-alluvial of the diggings.

There is nothing to urge in favour of a theory that the present alluvial gold is a concentration of older alluvial gold belonging to the Ordovician sandstone. The fact that here and there some gold has been found in quartz veins shows that the Lisle gold must be referred to the granite magma. Consequently, wherever the gold appears along this line—Diddleum, Lisle, Golconda—granite appears also. There is a genetic relationship between the two. The formation of the one has been accompanied by the birth of the other. Whether, therefore, the gold was a primary constituent of the consolidated granite (of which there is no proof) or was deposited in veins either through the granite, or proceeding from it, or in solutions expelled from the granite magma, its approximate age is that of the granite, *i.e.*, Devonian. Its distribution through the unconsolidated formations which have been worked by the miners was effected long subsequently—in late Tertiary and Quaternary times.

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* See E. Weinschenk. Grundzüge der Gesteinskunde, 1907, II. p. 40.—"Granitic stocks often show that the core of the massif is composed of a two-mica granite, which gradually loses its muscovite contents in an outward direction. Biotite granite is thus formed, and to this hornblende is added: the plagioclase contents become more and more important and finally genuine plagioclase rocks, diorites, even gabbro, represent present facies of the granite."

(5.)—*The Intrusion of the Diabase.*—Although a few stones of diabase may be gathered in the soil of the valley, it is, strictly speaking, an outside rock, and certainly had nothing to do with the deposition of gold. Mt. Arthur and Mt. Barrow are crowned with it, and on their flanks are the Permo-Carboniferous fossil-bearing strata, which it has pierced, or between the beds of which it has forced its way. In either case the gradual erosion of the overlying measures has exposed the igneous rock on the present summits. The Mesozoic sandstones in this district seem to have been completely denuded, and thus proof is wanting here of the uppermost limit of the diabase, but elsewhere, wherever the upper coal measures survive, there is decided evidence of their penetration or disturbance by this igneous rock. Its intrusive character explains the widely different positions which it occupies in relation to the sedimentary strata in various parts of the island. In the south, section after section may be seen, showing it capped by the Permo-Carboniferous mudstones, while in the north, the relative position is reversed, and the summits of the mountains are occupied by the diabase.

As might be expected, its contact effects on contiguous strata are never extensive. A development of iron ore, calcite, or chalcedony in the strata passed through is frequently observed for a few feet from the contact. Shales at the contact are hardened into chert or adinole, and it is not certain that the opal occurrences at Bothwell are not due to the influence of this intrusive rock.

(6.)—*The Outpouring of the Basalt Lava.*—Although the basalt on the farms overlooking the Lisle Valley reaches a height of 1800 feet above sea-level, it was probably much lower when it first flowed over the land. We know that at that time (Middle Tertiary) Northern Tasmania was undergoing a movement of slow subsidence, during which the Launceston Tertiary basin was filled with clay and sand sediment to the depth of 1000 feet, so that most likely the basalt which is now on the high divide was then flowing at somewhere near the level of the present Lisle township, or not far above it, for the subsequent elevation was perhaps not quite so great as the previous subsidence. There is no clear evidence that the basalt ever flowed over the ground which has been removed to form the Lisle Valley. It seems rather to have followed some depression of the surface towards the north-east in the direction of the Little Forester River.

(7.)—*Late Tertiary and Recent Sedimentation.*—With the rising movement of the land after the lava flows alluded to above, the process of valley excavation at Lisle began, and has continued to the present day. The principal water-channel, with its tributary creeks, carved its channel deeper and deeper, cutting down through the sandstone and slate strata which once stretched right across the valley, and eventually laying bare and entering the granite foundation. This slow, resistless process has been at work for ages, assisted by rains and weather, breaking up the solid rock, releasing the quartz from veins, pounding it unceasingly to sand, draining off sand and water to the sea, collecting the residual gold. After Nature's slow, tireless toil, man appears on the scene, an army of miners descends upon the valley with box and cradle, and after a short period of feverish industry depletes the accumulated store of metallic residues and departs. The history of the invasion may be told in a few words.

V.—HISTORY.

The brothers Bessell discovered the field at the end of 1878, but it was not until January, 1879, that the rush took place. On the 11th January 14 ozs. of gold were brought to Launceston, and by the end of the month there were a hundred diggers on Main (then called Bessell's) Creek, working ground 4 to 10 feet deep, with 15 to 18 inches of wash-dirt. On the 12th of March His Excellency Governor Weld visited the spot and named the township Lisle, in memory of the name of Mrs. Weld's family, which was De Lisle. By the end of that month a thousand men were working on claims extending for over a mile, and bringing in from £2 10s. to £15 per week per man. The reports of that year show that the population increased to 2500. The yields seem to have ranged from £4 to £12 per week per man for the most part. In some cases the highest figure exceeded this, while many only earned a living. By the end of 1879 the place had settled down to steady work. The reported yield of the field was then about 400 ozs. per week. The field was a very active one for three or four years, but after a rush which took place to Temora, N.S.W., work fell off considerably.

Mr. Charles Bessell has furnished me with much interesting information relating to the produce of the field in the early days. The best shows were:—(1) Donnelly's terrace (at these workings 1000 ozs. were got from 1000 loads). (2) Lockwood's terrace, where 600 ozs. were got in one year. (3) The Main Creek, all along which from £4 to £10 or £12 per week per man used to be made. The sides would yield an ounce per man, while the centre was much richer. A little to the west of the creek one man cleared £2500. In the creek opposite the post office 550 ozs. were won; and higher up the creek, at the Red Cliff, a couple of hundred ounces have been won from less than ¼-acre; and below this, 600 ozs. came from ground not exceeding ½-acre in extent.

The terraces were very rich in patches, Donnelly's being remarkably rich, but the creek was good all the way up, with hardly a "duffer" claim on it.

The total output of the field cannot be stated precisely, as only a small proportion of the gold won was sold in Tasmania. The Government returns show about 84,000 ozs., but there is reason to suppose that this is less than one-half of the real produce. Mr. C. Bessell, who took the trouble to obtain as many certificates from buyers as he could, and made numerous enquiries in reliable quarters, with a view of getting as near to the true yield as possible, is of opinion that it is in the neighbourhood of 250,000 ozs. Some have named still higher figures.

The present output as reported to the Mines Department is from 30 to 40 ozs. per month, but there is reason to believe that it is actually slightly in excess of this.

VI.—MINING.

The ground which has been worked, and some of it reworked, forms a belt of 500 or 600 feet in width along the Main Creek, and also a belt on the western side of the valley along Bessell's Creek. The tributary creeks have also been sluiced. The large terraces at the foot of the hills on each side of the valley have likewise been worked with great success. The occurrence of the gold seems to follow no regular rule, being sometimes distributed irregularly through the deposit from top to bottom, and in other places being won from a foot to 6 feet of wash lying on the soft granite bottom. The deepest ground on the creek is perhaps that near Langley's--16 feet. The ground forming the terraces is now spread out fan-like at the foot of the hills, and the small creeks have intersected it. Displacements of it have apparently occurred, and any tunnelling into the made ground is uncertain. Tertiary faulting is supposed to have taken place, disturbing the clay deposits, and interfering with some of the mining operations. The terrace stones are distinctly angular, and waterworn only in the bottom wash, while in the creeks they are rounded. A low ridge of soft granite separates the gold-bearing ground on the east side from that on the west side, and the miners say that they recognise differences in the appearance of the gold won from the different sides of the valley, and that the western gold realises about 10d. per ounce less than that from the eastern part of the field. The mint value of Lisle bullion is about £3 18s. per ounce.

The claims at present being worked on the field are as follows:—

(1) W. Kerr, in the upper part of Main Creek.
(2) Bailey's claim, also up the creek.
(3) Watts and Langley, under the cliff.
(4) Marshall and Faulkner, a little lower down.
(5) Marshall, also in the creek below the preceding
(6) C. Bessell, in Main Creek.
(7) E. Bessell, in Main Creek.
(8) Jno. Kerr, in Main Creek.
(9) Watts' claim, in Donnelly's Creek.
(10) Watts Bros.', in Main Creek (lower part).
(11) Schlobohm, up Bessell's Creek.

(12) Lockwood's terrace, Harmansen's claim.

(13) H. Faulkner and Marshall, on Thomas' Creek.

These give employment to 23 men, all of whom are making a living, so that the field cannot be properly described as worked out.

Red Cliff.—The Cliff workings are in the part of the field where the old Mt. Arthur P.A. carried on exploratory work. It drove three tunnels into the eastern hill, where deep alluvial ground exists under a spur between two small creeks. Soft granite was driven through, and an east and west alluvial channel met with, filled with boulders and stones of quartz and sandstone. A little gold-bearing gravel was struck, but this cut out, and only broken barren material was passed through after this. The gold which was found is stated to have been angular, and with occasional pieces of quartz attached to it. The lead is supposed to have been dislocated and broken up by faults. However, this may be, extensive landslips have taken place on this slope of the range, and it is now difficult to locate the exact position of the original channel. This point is about 1½ mile up the creek from the gorge, and not much gold has been obtained higher up. The source of the Main Creek gold is therefore practically restricted to the eastern side of the Lisle Valley for 1½ mile in length.

At present the Cliff, or Red Face, is being worked by Watts and party, where there are about 10 feet of overburden overlying 4 feet of wash, which rests on the soft granite. The gold is not much water-worn, and is rather a coarse variety for Lisle. A flat piece, weighing 1 dwt., has been found recently, and several pieces weighing 6, 8, and 10 grains have been obtained. The ground is clean—not scaly; and has the reputation of being the best on the field. A few small sapphires and rubies have been found in the wash.

The most frequent stones in the dirt consist of the dark metamorphic and brown sandstone. Stones of chalcedony are fairly common, some of them containing pyrite. I was informed that a seam of pyrites was once found in the granite bottom; otherwise pyrites is absent. The iron-magnesia spinel (pleonaste), known on the field as black-jack, occurs in the wash, occasionally in large sizes. I saw a crystal of this embedded in vein quartz in Marshall and Faulkner's workings on the western side of the valley. The gold obtained is free, but 2 or 3 grains have been found adherent to pieces of quartz of equal size.

J. Faulkner and Marshall.

A gully just north of the Red Face is being worked by Marshall and Faulkner. The ground consists of alluvial matter with stones of bluish and reddish sandstone. Large boulders of the bluish sandstone are scattered about the wash. Few stones of quartz occur. The wash of waterworn stones rests upon an irregular surface of granite, and has probably been the bed of the old Main Creek, which has gradually worked its way down to its present channel in the flat.

The ground has been worked up towards the head of the gully just below the track, where the last work done was four loads for 11 ozs., and then both gold and wash gave out. Towards the hill among the ferns there is deeper ground, 40 feet, and no bottom. Under Mr. A. Bessell's house the granite is even 70 feet below the surface. It is noteworthy that gold is obtainable here in the surface soil. Up the hill it can be got in the grass over a loose stratum of sand and stones 40 feet deep.

Callaghan's Creek.

The creek called Callaghan's flows into the Main Creek on this side of the valley, and has been worked for gold, but was not considered good ground. It was the highest payable alluvial at Lisle, and the best part of it was up near C. Bessell's house. The knob of ground there has gold at the surface, but this seems to cut out at that spot. Mr. C. Bessell states that it is the only place where he obtained some specimens of gold and quartz. The largest piece of quartz was the size of a pea, and had half a dozen little specks of gold in it.

Kelly's Creek.

Near the post office is another small creek, Kelly's by name, which has also been worked a little. It heads from a little distance up the hill, still in the granite zone.

C. Bessell.

A claim on the Main Creek opposite the township houses is worked by Mr. C. Bessell with fair results.

Cox's Creek.

Near the schoolhouse, Cox's, or Slaughteryard, Creek flows into the Main Creek. Its source is near the contact of the granite with the sandstone. Fairly good gold was won from its lower part, but the creek became poorer higher up. All round the valley is a kind of ledge which marks the upward limit of the granite. The drainage of the hill sinks through to this floor, and from it issue the head waters of the various creeks.

Donnelly's "Terrace."

Further north are Donnelly's Creek and Terrace workings. Close to the road is the rising granite bottom, a point of soft bed-rock on which T. Clare worked 4 feet of terrace for 1000 ozs. per 1000 loads. The old paddocks of terrace stone stretch up the hill to the east on the gently sloping granite floor to the 15 feet of standing terrace face, which has been tunnelled into at the base on the bed-rock. The top part of the terrace for 10 or 11 feet consists of clay and angular stones of reddish sandstone, highly micaceous and ferruginous. These have evidently crept down the hill as superficial detritus, and from their shape it is clear that they have not been moulded by river action. At the same time a certain linear arrangement of the stones seems to suggest that they formed part of shore-beds—perhaps on a lake beach. This rubble-bed passes downwards at one part of the face into a bottom layer of yellowish drift sand and clay 4 feet thick. This layer contains some rounded pebbles, and yielded the heaviest gold. At the same time prospects were obtained from the upper beds, and nearer the road gold was won from all through the deposit, which there consisted nearly entirely of surface clay, with scarcely any stone. I am informed that Donnelly's workings contained a good deal of chalcedony and quartz. The wash evidently had a distinctive character of its own.

Titmus Upper Tunnel.

The highest mining work on the field is that which was done at the Titmus upper tunnel above the Police Reserve and not very far below the crest of the hill. A shaft was sunk on a small leader in soft granite for 60 feet, and afterwards a tunnel was put in a little higher up, apparently on the same vein in sandstone. A good distance was driven without a trace of gold, and work was finally suspended and the drive caved in. I picked up specimens of quartz at the approach, but these on crushing and washing proved to be quite barren. This tunnel is in sandstone country above the granite contact.

Titmus and Dodgshun's Tunnel.

A little lower down the hill Titmus and Dodgshun drove a tunnel 80 feet or thereabouts in soft granite. Mr. Montgomery reported in 1894 that there were five or six small auriferous veins, ¼ to ½ inch thick, of quartz and kaolin in the granite, coursing in a direction N. 76° E. Some of the quartz was sent to Launceston to be tested, and returned 3 dwts.

Lisle Dredging Company.

In the latter part of 1901 a Launceston company (the Lisle Dredging Company), commenced working the alluvial gravel in the Main Creek with a suction plant. The ground was estimated as worth 1s. per cubic yard, and the working costs as not over 6d. per yard. It was considered that as the old miners left all ground which yielded less than 5s. a yard, there would be ample margin for profit. However, the buried timber proved a great obstruction, and the number of times that the dredge had to be moved militated against cheap working. The ground, too, turned out to be nothing like so rich as was anticipated, and after three years' struggling with various hindrances—shortage of water, &c.—operations were suspended. The quantity of gold reported to the Government as won amounted to 1605 ozs.

Bessell's Creek.

At the north end of the field Mr. Schlobohm is working up Bessell's Creek. At this end the western and the eastern runs of gold-bearing drift seem to junction. Where Bessell's Creek joins the Main Creek a bar of granite crosses, and the best nuggets found in Lisle came from this locality. The largest one was discovered by T. Bessell, and weighed 15 dwts. The first one found is in the possession of Mr. W. F. Petterd, and weighs 1 dwt. 2⅕ grs. Several have been found weighing from 1 to 2 dwts.

Thomas' Creek.

Marshall and Faulkner have a 5-acre section (714G) in the western part of the field on Thomas' Creek, where they are working a face by hydraulic sluicing. This terrace shows bedding lines and carries waterworn stones, suggesting former river action. Below the surface is red ironstone gravel for 4 feet, resting on 4 feet of sandy silt. Below this is a stratum of stones of quartz and grey sandstone for a foot in thickness, which rests upon 6 feet of clay and stones of slate. The whole deposit lies on granite bed-rock. In each bed there is gold, but the heaviest gold is on the bottom. The bottom wash contains pieces of granite and purple slate, and granitic mica is a constituent of the sand between the pebbles. The stones of blue metamorphic sandstone, so frequent in the deposits on the eastern side of the valley, are rarely found here. The extent of the auriferous ground has not been proved yet, but apparently its channel has proceeded from the hill to the south-west.

Further south a few colours are found in Stony Creek, and this does not suggest that there is much worth speaking of south of that creek.

Lockwood's Terrace.

North-west of Marshall and Faulkner's workings is the extensive patch of deep ground known by the name of Lockwood's Terrace. This is on a ridge which forms the end of a spur coming down from the western hills, and was worked in a good many places at one time, as many as 500 men being on the ground at one place or another. The deepest ground which has been bottomed is 60 feet. A shaft 60 feet deep was sunk, and 2 grains to the dish stated to have been prospected from the bottom. One, Currie, had a claim and puddled his dirt for 160 ozs., according to report. Lockwood's dirt, too, lower down, used to go 1 oz. to the load. Harmensen's face is 19 or 20 feet deep, with 4 feet of subsoil resting on 3 feet of horizontally bedded clay, which in its turn covers 12 feet of wash on granite bottom.

The drawback to the work on this terrace was want of water, and it is very probable that if water could be brought to it, the ground would still pay to work. The best gold, as usual, was found in the wash at the bottom; still, a little was obtained all through the deposit. Very little of the bluish metamorphic sandstone and slate is found here; the stones of quartz belong to a more kindly variety than that on the east side of the valley, and the gold apparently has not been derived from that side.

Mt. Arthur Properties, Ltd.

In this part of the valley several sections have been taken up by the Tasmanian Consols, Limited, on behalf of the new company, the Mt. Arthur Properties, Ltd., recently registered in London, with a capital of £65,000. A few preliminary bores have been put down in this ground to depths varying from 9 to 26 feet. Layers of heavy wash and boulders made it very awkward ground to test by boring. The holes were deflected, and in most instances the pump could not follow the auger. Notwithstanding this, gold was got in five out of the seven holes. Two holes gave 0·57 and 1·323 grains gold per cubic yard; two gave 1·728 and 2·16 grains; and one gave 8·748 grains per cubic yard. The testing work will shortly be resumed. The company contemplates working this flat, and as it is mostly virgin ground, the difficulties experienced by the Lisle Dredging Company in the worked ground along the Main Creek will probably not recur.

OBSIDIANITES.

Several of those interesting objects known as obsidianites (Australites) have been found in the wash at Lisle associated with the gold. Some recovered by Mr. Bessell were lying together on the granite bottom 17 feet from the surface. The forms known here are the circular button shapes, the dumb-bell shapes, and the beetle shapes. Some of these have been obtained from the gravel below the Red Face workings, so that we can say positively that they could not have travelled far; in fact, it would be possible to circumscribe an area a few hundred feet square within which they must have fallen. The proof of age is not precise, but it would certainly be Late Tertiary or Recent—not pre-basaltic. These obsidianites consist of acid or sub-acid volcanic glass, and not of such glass as would result from the emissions of any Tasmanian volcanoes. The proximity of the basalt sheet at Lisle is an accidental feature which is unrelated to the occurrence of these objects. It is sufficient to call to mind that they have also been found at Cox's Bight in the tin-bearing gravel in the extreme south-west of Tasmania, where there is no basalt whatever, the nearest being in the Huon basin. Their real origin is still a matter of debate, the theory which meets with most favour at present being that the glass is meteoritic.

VII.—THE DERIVATION OF THE GOLD.

Whence all the gold has been derived which has been won in the form of alluvial has long been a mystifying puzzle, baffling the prospector and the visiting expert alike. A quarter of a million ounces have been obtained from a mere fractional portion of an area not exceeding a mile and a half square. The bulk of this has been sluiced from the bed and banks of the Main Creek and from terraces sloping down to it on the eastern side of the valley; the remainder has been won from small creeks on the opposite side of the basin and from terraces above them.

The remarkable feature of the field is that no reefs have been found either in the valley itself or on the surrounding hills. Certainly some quartz veins must exist concealed beneath the mantle of overburden which clothes the hill-sides, because numerous stones of quartz occur in the drift; but this quartz is barren. No gold-bearing quartz has ever been seen in the workings, beyond a minute specimen here and there. Yet nearly everyone who works on the field or who prospects it has in his mind the eventual discovery of a parent reef or reefs which have shed the gold. A little reflection will show how unreasonable such a notion is. Anyone standing on the floor of the valley finds himself in a locked basin, walled all round by hills 800 feet to 1000 feet high, and cannot escape the conviction that whatever may be the source of the gold, the whole of it has been derived from points within the area upon which he gazes. The auriferous overburden which covers the bed-rock has not been brought by torrents from afar. The gold has not travelled. The terraces consist of hill detritus—not of shingly beds. Apart from the bottom wash of the terraces, the only shingle in the valley is that of the creeks or of their ancient beds. The creeks themselves are contained within the valley walls. With these conditions one cannot escape from the conclusion that if the gold has been shed from quartz reefs specimens of auriferous quartz will be found in the workings. But such quartz is absent, and the inference therefore is irresistible that the gold won must have been derived from some other source. This is the starting point from which any intelligent investigation of the phenomena must begin. There may possibly be a few gold-bearing veins in the surrounding hills, but any gold which they may have contributed must have been inconsiderable in amount, and they may certainly be neglected in this inquiry. A useful preliminary in the investigation will be to scrutinise closely the nature of the stones with which the gold in the alluvial workings is associated, as from such scrutiny some definite information will certainly emerge.

I confine my remarks first of all to the eastern side of the valley, as the bulk of the gold has come from the Main Creek and the eastern terraces.

1. The stones in the alluvial and terrace ground are mainly metamorphosed sandstone and slate from the hillside above the granite contact. The most abundant are bluish stones which bear a superficial resemblance to basalt. Some of them are quartzite or metamorphic sandstone; others, more compact in structure and of argillaceous nature, are altered slates. The rock has undergone intense metamorphism by reason of the influence of the intrusion of the granite. These stones contain a good deal of iron, and have a habit of crustal weathering which proceeds inwards till often only a kernel of the hard blue rock remains in the centre. The miners call this becoming coated with sandstone, and significantly state that it is characteristic of the deposits where gold is found. The importance of this statement will appear later.

Some reddish brown micaceous sandstone also appears in the detritus, and at Donnelly's terrace this is the almost exclusive component of the drift, the dark bluish variety being almost absent there. This is explained by the brown sandstone being *in sitû* on the hill above the terrace. The stones there are highly ferruginous and micaceous. Their mica may be considered as a result of the granite contact and the iron as derived from the decomposition of the ferro-magnesian mica.

The stones, therefore, which form the bulk of the gold-bearing drift have been derived, not from unaltered strata, but from rock which has been strongly modified by contact with intrusive granite.

2. Stones of chalcedony are frequent in the terraces, especially at certain points. A few of these stones picked up in the old workings under the Red Face contained disseminations of cubical white iron pyrites.* The stones have probably been released from veins in the granite and along the granite contact line. Mr. C. Bessell many years ago drove a tunnel in the western hill to the contact line, which he found marked by a vein of chalcedony.

Many of these stones look as if they had been cut or chopped with a chisel on each side, while their substance was in a soft condition. The Germans call this "chopped quartz."* Such stones are common in the tin drifts in granite areas on the East Coast, and have given rise to a good deal of speculation as to their mode of origin. They probably represent veins in the granite, and the gashes are the moulds of crystals of felspar projecting inwards from the vein-walls.

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* These assayed in the Government Laboratories by Mr. G. Oliver Smith, Government Analyst, yielded a trace of gold.

No gold has ever been noticed in any of the stones of chalcedony met with in the workings.

3. The stones of granite which appear in the drift are infrequent. The granite bottom is invariably soft, and consequently it can hardly be expected that the alluvial will contain pieces of the hard rock. No reefs have ever been seen in the granite floor.

4. In places there are large stones of white barren quartz in the wash and detritus. These have not been traced to the veins from which they must have proceeded. It is surmised that such veins must exist in the sandstone. Small veins of quartz have been noticed here and there in the stratified rock, *e.g.*, at Titmus' upper tunnel, and on the western range, but these are unimportant and have no real bearing on the question.

The terraces on the western side of the field have evidently derived their gold from the hill on that side. The blue sandstone is not so common on that range, and the wash contains more slate. The same contact conditions prevail there, the granite bed-rock rising up the hill-side to junction with slate and sandstone.

Coming to the consideration of the derivation of the gold, it is quite possible that some of it may have come from soft pyritous or micaceous veins in the granite bottom, which have gradually worn away with progressive denudation. This, however, is pure hypothesis, and no proof is available. Some source, however, other than hard quartz veins must have existed.

An important clue to the solution of the problem is furnished by the discovery of visible gold in the dark metamorphic sandstone frequently referred to in this report. One of the rock specimens which I brought home showed distinct specks of gold free from gold or pyrite. Unfortunately, I have not been able to observe this in any other specimens, though I have broken hundreds of stones. However, the fact that gold is present in the sandstone is undoubted, and is sufficient to outweigh innumerable negative results.

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* Zerhackter Quarz.

The suggestion which I advance is that the bulk of the Lisle alluvial gold has been derived from the wasting away of the impregnated stratified rock near its contact with the granite.

Until we know more about the occurrence it is premature to attempt to range it definitely with other deposits, with which it may eventually prove to have little in common. We do not know yet whether the impregnations in the sandstone are connected with reefs proceeding from the granite, or whether a promiscuous deposition took place from siliceous solutions expelled from the granite during cooling, or some subsequent action took place along the contact line, distributing the gold in the adjoining rock.

In various parts of the world impregnations of gold in stratified rock have been recorded, but these seem always to be connected with quartz veins. One can only surmise that at Lisle the sandstone near its contact with the granite has been saturated with silica from the plutonic mass, and that the gold-bearing siliceous solution has deposited its precious freight in the interstices of the sandstone. The gradual weathering of the rock has liberated the gold, which, together with the detritus and wash (eluvial and alluvial) has found its way down hill to the terraces and creeks. All the facts and features of the field are in harmony with this view.

The impregnation may be irregular, and if so, it will not be easy to find the metalliferous patches. Even when found it does not follow that they will prove payable. The only way to test the occurrence is to remove the overburden on the hill-side and lay bare the bed-rock at the contact. The contact line from Donnelly's to behind Bessell's would be the most likely locality for this work. The task is not easy, as the overburden is heavy, and the position of the hidden line of junction has to be guessed at.

I took grab samples freely from the dark sandstone left in the paddocks from dredging and sluicing along the Main Creek, and these, assayed in the Government Laboratories by Mr. G. Oliver Smith, Government Analyst, yielded a trace of gold. Samples of the red ferruginous sandstone in Donnelly's terrace yielded nil.

VIII.—COUNTRY NORTH OF LISLE.

The Ordovician slate and sandstone continue north of the township to within a mile of the railway, when they are interrupted by granite. On the road opposite the Falls, in the Lisle Creek gorge, the dark metamorphosed sandstone crops out, and on the west side of the gorge near the bar the brown sandstone is extremely micaceous, and has a microscopical structure resembling that of some of the crystalline schists—a structure which has been imposed upon it by the intrusion of the granite.

The general strike of the strata continues throughout the whole of this area, being for the most part about N. 30° W., though in some places up to N. 50° W., and the dip is uniformly in a north-easterly direction. In the bend of the road opposite F. Witte's house the bedding lines can be seen to be horizontal or slightly undulating.

Valentine Creek, which flows into the Little Forester River a mile south of the Lisle-road station, marks the junction of the slate and granite. On the north bank of the creek a surviving fragment of the ancient Little Forester River bed shows itself resting on granite at a good height above the existing river. On this granite ridge the schoolhouse is built, and it trends from that spot in a westerly direction. Northwards it sinks below alluvial gravels, which extend to the railway-line.

The granite is biotite-granite, of much the same type as that at Golconda and Lisle, and as it has also a mantle of slate and sandstone of similar age, its contact line ought to show indications of reefs or mineral deposits. I have not heard that it has been prospected very thoroughly.

Tobacco and Cradle Creeks.

Two miles north-west of Lisle, and on the southern boundary line of the Parish of Shaw, are some mining sections in which Tobacco and Cradle Creeks take their rise. These creeks flow north-east for nearly a mile and then unite, subsequently junctioning with the Lisle Creek. The sections can be reached from Golconda; they are not more than a mile south-east of the New Enterprise Mine. I visited them from Lisle, joining the Lone Star track on the crest of the hill west of Lisle Creek. Stringy-gum and sassafras clothe the side of the range, but at the top stringy-bark country is entered. Near the sections Middle Creek is crossed, a small stream flowing into Tobacco Creek and usually carrying about a sluicehead of water. No gold has been found in this creek.

Mr. C. Bessell discovered Tobacco Creek and gave it its name 18 months before he discovered Lisle. Cradle Creek owes its name to the work which was carried on in it. From these two creeks about 2000 ozs. of gold have been won.

I found an old prospector (Manson) in Tobacco Creek reworking old ground, with about 10 feet of clay overburden and 6 to 18 inches of wash resting on slate bottom. The stones of slate in the wash are angular, and the gold is not waterworn. When pieces of any size are found the gold is usually attached to quartz. The run of gold extends for nearly 20 chains, and has been worked up to the brow of the hill. It keeps at first to the creek, but finally leaves it and turns north-west up the hill. The gold in this creek is coarser than at Lisle, and nuggets up to 15 dwts have been found. The ground has been worked over three or four times, the workings widening each time. At the top of the hill which is between the two creeks a good deal of trenching has been done and some quartz veins have been found, one of which carried gold. A shaft was sunk on it for 25 feet, but the metal died out. A long tunnel was put in from the Cradle Creek side of the divide, but nothing was found past the entrance. On the summit of the ridge is an ironstone reef with a little quartz in it, very similar to many of those which occur near Lefroy. It appears to be conformable with the slate, and is not very promising to look at.

In the lower end of Cradle Creek the gold is extremely fine, and the wash is all quartz.

There seems to be no doubt that the gold won in the two creeks has been derived from the hill which divides them, and has been contained in quartz reefs. There was a rush here of 50 or 60 men some three or four years after work at Lisle began, and it is strange that the veins which shed the alluvial gold were not discovered. The area within which search has to be made is small, and it would seem that there is here a field in which a little capital might be usefully expended in exploration.

IX.—COUNTRY SOUTH OF LISLE.

The Ordovician strata of Lisle are prolonged south-east to Mt. Barrow and the North Esk River. Once removed from the immediate influence of the granite the slate becomes normally a grey greenish and purplish rock, with cleavage-planes having the usual north-westerly strike and north-easterly dip. Already at the head of the Lisle Valley the dark metamorphic slate and sandstone give way to purplish slate. From Faulkner's farm south-east to St. Patrick's River the stratified rocks are covered by a narrow strip of basalt and basaltic soil, which follows the river down to Patersonia and further south to Mt. Edgecumbe and along Distillery Creek.

Several quartz reefs are known between Lisle and St. Patrick's River, but they are white and barren, and have been little prospected.

In the road below the St. Patrick's River post office a reef is exposed striking south-east and dipping north-east. It transgresses the country, and consists of seams of quartz alternating with chloritic and felspathic bands for a width of 1½ feet. It is a persistent reef, for it runs south a good distance on R. Wilson's land. On Warren's land are reefs or dykes of somewhat similar nature. Microscopical examination shows these decomposed greenish formations to be hornblende-granite dykes, and they no doubt have some connection with the hornblendic granite of Diddleum and Camden Plains.

Some boulders of granite porphyry apparently mark the line of a dyke or other granitic intrusion running north-east on J. Millwood's section, north-west of J. M. Peck's 100½ acres, across the river due west of the reefs just mentioned. These boulders are in slate country, but 10 chains south of them some Permo-Carboniferous mudstone with casts of spirifers is exposed on the road.

On Hart's 228 acres, on the road towards Sullivan's Bridge, is a wide red formation containing decomposed syenitic dyke-rock. The adjoining purple slate has here produced much red soil. No quartz is visible in the formation, but it is stained with manganese.

A little north is Brook's shaft, by the roadside. This was sunk 50 feet by a Launceston syndicate 10 years ago. Rumour says that assays of lead, gold, and silver were obtained. At present nothing can be seen beyond the grey slate thrown out of the shaft and a few stones of white vitreous-looking quartz mottled with specks of greenish slate and manganese oxide.

At Irishman's Gully, running into the basalt zone west of the St. Patrick's River, a little sluicing has been done and some gold obtained, but the quantity is not known. Above the junction of Patersonia Rivulet with the river, where the basalt crosses the former, some paddocks of dirt were opened out and some gold won. It is reported that some precious stones were found here. These were probably sapphires, as some have also been got at Camden Plains.

I did not go on to Camden Plains, which have long been known as a gold-bearing field. I am informed that there 9 to 10 feet of wash rests on the granite bottom. The granite is hornblendic. The gold is excessively fine, and no nuggets are found.

Looking upon this district as a whole I do not anticipate that payable reefs will be found. I suspect that, as a rule, the gold which has been won in small quantities at different places has been shed from the lines of contact of the granite with the stratified rocks, and that though in the aggregate a fair quantity may have been liberated by denudation, it has been distributed by the drainage system over so wide an area that the concentrations of metal at the different points are not likely to be very remunerative.

There is, however, just a chance that some deposit a little above the average may be met with.

Mt. Barrow (4644 feet) is crowned with columnar diabase, and several hundred feet from its summit is fringed with sandstone and Permo-Carboniferous mudstone. The upper beds of the fringe consist of calceous mudstone charged with fossils, and the lower beds comprise sandstone and boulder conglomerate. also fossiliferous. These are about 1100 feet in thickness. They repose in horizontal layers upon the steeply inclined slate strata of the Ordovician system. Down in the St. Patrick's River Valley, at Maclaren's Turn-off, soft Permo-Carboniferous mudstone is again to be seen in the road drain.

A mile and a half further south, east of the main-road, is Bourke's sandstone quarry, with a cliff of freestone several chains long and 30 feet high. The stone is of even quality and grain, and free from iron. It looks as if it would make an excellent building stone. Samples may be seen at Mr. Silvanus Wilmot's stone-cutting yard, Brisbane-road, Launceston.

The diabase which surrounds Launceston plunges beneath the alluvial of the North Esk Valley and crops out in Mr. Fry's paddock on the Elphin-road. It passes below the Tertiary sandstone of the Windmill Hill and below the flat land at the junction of the North and South Esk Rivers. It has been found by boring at the Tamar-street Bridge 55 feet down. Processes of denudation have therefore in the course of ages removed the overlying Tertiary and Permo-Carboniferous strata, and have eaten into the diabase floor itself to a considerable extent. The thickness of the Launceston Tertiary beds may be gauged by the depth of the bore which was put down at Carr Villa—570 feet—before touching the diabase rock below. The old alluvial bottom began already to rise in later Tertiary times and with the new land configuration the North Esk River selected its present channel. The result has been the formation of the Cataract Gorge, certainly not, as is often imagined, a display of volcanic energy, and probably not due to any disruptive force, but simply the carving out of a channel by the ceaseless but irresistible action of running water, assisted by a gradual elevation of the land.

W. H. TWELVETREES, Government Geologist.

Launceston, 10th October, 1908.

X.—APPENDIX.

ON THE DETERMINATION OF HEIGHTS.

The heights on this journey were taken with a 4-inch aneroid and a Casella's hypsometer. and to ensure an approximation to accuracy the calculations are based on readings taken during the last days of the period. It is now well known that aneroids give higher readings during the first few weeks of their stay at upper stations than they do subsequently. After a few weeks, if not used in further ascents, they recover and behave normally, probably increasing their index error in the process.

The results obtained with both of these instruments are inferior to observations taken with a mercurial barometer, but the transport of the latter is extremely inconvenient, requiring, as it does, continual attention and care. In fact, one man ought to be detailed to carry the barometer alone. The least inconvenient form is the portable mountain barometer made by several firms especially for explorers. For transport the cistern screw must be turned sufficiently to force the column of mercury to the top of the tube, and the instrument must then be carried upside down. While in this position loosen the screw half a turn so as to afford a little play to the mercury. If these precautions are not observed the instrument will come to grief. One cause of annoyance is that on mountain tops in a strong breeze the slender tripods supplied with the barometer vibrate unpleasantly and cause unsteadiness.

My boiling-point apparatus on this trip persisted in reading higher than the aneroid by 50 to 100 feet. I have generally used this method as a check on the aneroid with tolerably fair results. Of course it has been proved to be inferior in point of accuracy to the mercurial barometer, but nevertheless, on account of its convenience, it is much used by travellers. In using it, it should be borne in mind that isolated observations are not of much value. At least three observations should be taken with different thermometers and the mean adopted. Thermometers, even by good makers, are not infallible, and as they increase in age they are apt to give too high temperatures, and consequently the calculated height is lower than the actual height. The value of one degree Fahrenheit on the thermometer tube in making the first ascent from sea-level is about 519 feet. It can therefore be readily seen what accuracy is requisite if fractional readings are to be reliable. Moreover, the value of the degree increases with the height above sea-level, so that instrumental errors and errors of observation ought to diminish as the ascent is made, which is not the case. Further, on looking through the literature of the subject, it does not appear at all certain that the barometric pressure corresponding with the various boiling-points has been accurately ascertained, and this adds a new source of possible error. In the earlier forms of the apparatus the purity or impurity of the water boiled affected the results, but in the hypsometers now obtainable, the thermometer, both stem and bulb, is immersed in pure vapour, so that the kind of water used is immaterial. For travellers' use, Casella publishes a set of tables, from which the following figures are taken:—

Boiling point temperature.	Approximate height above sea-level.	Difference for each degree.	Corresponding height of barometer.
degrees.	feet.	feet.	inches.
212	—	—	29·922
211	519*	519	29·335
210	1041	522	28·756
209	1566	525	28·185
208	2094	527	27·623
207	2623	529	27·070
206	3154	531	26·527
205	3686	533	25·993
204	4221	535	25·468
203	4757	536	24·952
202	5295	538	24·445
201	5834	540	23·946
200	6376	542	23·456

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* Multipliers for the temperature of intermediate air and corrections for decrease of gravity as per tables given later in these notes must be used when the difference of height between two stations has to be calculated.

Aneroids.

There are many aneroids scattered about the country, and their possessors often suffer illusions in respect of their value for giving heights, and are, besides, inexperienced in their use for that purpose. The aneroid barometer cannot be called a tool of precision, notwithstanding various refinments of scale, verniers, &c. It is unreliable for contours of, say, less than 30 feet. Several unsatisfactory features are attached to its use, and great care has to be taken when employing it for the determination of heights. It is usual to hear travellers justify their determinations of mountain heights by laying emphasis on the fact that their aneroid needle has returned to its original base reading on the completion of their descent. This very fact would furnish grounds for suspicion, because the natural tendency of an aneroid in normal working order is during the ascent to lose or read higher than the true height, and in descending the opposite tendency or one towards recovery prevails. The two tendencies, as Mr. Whymper has shown, counteract each other, and the result is a retarded recovery, so that if a reading is taken immediately on completing the descent it will show less difference of air pressure than was shown by the ascent. Whymper states a rule: "All aneroids without exception lose upon the mercurial barometer when submitted to diminished pressure, and recover a portion of the previous loss when pressure is restored." He adds, that it is exceptional to find the loss exactly balanced by the recovery. The recovery is gradual, and sometimes exceeds the loss. Thus various index errors are acquired. A touching confidence is sometimes reposed in the Kew certificate when this is supplied with an instrument, but this is nothing more than a verification of the behaviour of the aneroid when under specific reductions of pressure in the maker's workshop. It is no guarantee of its behaviour during sustained fluctuations of pressure in the field. The certificate shows that care was taken in the manufacture, but the intrinsic foibles of ordinary aneroids remain unaffected. A clever and effective way of overcoming these disadvantages has been devised in the shape of the Watkin mountain aneroid, in which, by turning a screw at the back of the instrument, the pressure on the vacuum-box is exerted only at the time of taking the reading, and is relieved immediately afterwards.

Observers are advised not to rely upon readings at heights which are at all near the upward limit of the scale. Thus, an aneroid graduated up to 5000 feet cannot be used with safety to determine heights above 4000 feet.

A gentle tap applied to the instrument is often of use in starting the needle, though the motion in walking or riding is usually sufficient to keep it acting freely.

It should be always read in one position, as the indicator will read differently according as the aneroid is held vertically or horizontally. The vertical position is preferable, as it can be suspended freely from the hand by the ring only, and exactly on a level with the eye.

In mountain climbing the pressure in inches should be noted, and not only the mere elevation scale, as the barmetrical pressure will have to be used in the subsequent calculations. The scale of feet, too, may be taken as being less accurate than the divisions for pressure.

Mr. Whymper prefers aneroids of large diameter to those of watch size. On the other hand, the topographers of the United States Geological Survey use instruments 2 inches to 2½ inches in diameter. My own experience has been favourable to the use of the smaller size, if of the best construction.

The reading should be taken immediately on reaching the summit of a mountain. The height observed will usually exceed the true height by a little. The excess will be found to have increased if another reading be taken a little later. The later reading should be neglected, for it is not the result of sluggish action of the needle, as has been supposed, but is due to the continued low pressure, as mentioned above.

The usual and proper use of the aneroid is in determining relative, not absolute, heights. If heights above sea-level are desired, it is necessary to select a base, or lower station, the height of which is known from other sources. A railway-station, or some point the height of which above the rails have been ascertained, may be chosen as a base. Every opportunity of checking readings by repeated observations should be taken advantage of, for aneroids often behave in an erratic manner, and single observations are unreliable.

If a second aneroid is not kept in camp and read throughout the day by a second observer, it will be necessary to obtain the 9 a.m. and 3 p.m. atmospheric pressure from Hobart or Launceston, and deduct or add the mean of the daily variation. Thus, if at Launceston the barometer reads at 9 a.m. 30·20, and at 3 p.m. 30·10, the mean variation will be ·05. Therefore, deduct ·05 from the reading at field base in order to correct it for comparisons, say, at noon with the reading at the upper station.

To obtain correct temperature at upper and lower stations, use a standard mercurial thermometer made by a good firm. Shade temperature must be observed, and the thermometer should be suspended at least 10 feet away from any vertical rock face or cliff.

Some aneroids are furnished with attached thermometers which are supposed to show the temperature of the instrument, but good aneroids are commonly compensated for this, and the appendage is unnecessary.

In determining heights by aneroid in Tasmania two corrections must be applied to the reading, viz:—

Corrections—

1. Correction for difference of temperature between the lower and upper stations (See Table II.).
2. Correction for decrease of gravity due to height (See Table III.).

The use of these tables may be illustrated by the following example:—

9 a.m.		Launceston. Inches.	Lisle. Inches.		Launceston.	Lisle.
July 15.	Barom.	30·48	29·60	Thermom.	+ 39°	+ 32°
20.	"	29·50	28·75	"	+ 51°	+ 38°
21.	"	29·70	28·80	"	+ 46°	+ 34°
23.	"	30·08	29·15	"	+ 46°	+ 33°
25.	"	30·15	29·25	"	+ 33°	+ 28°
	Average	29·11	29·98		+ 33°	+ 43°
					38°	

Lisle......... 29·11 in. Table I. 27,916·1 ft.
Launceston 29·98 in. " 28,685·5 ft.

769·4 ft.
Table II. Mean temperature 38° = ——— 1·0132 multiplied.
769·4 × 1·0132 = 779 ft.
Table III. Decrease of gravity...... 1·94 ft.

Altitude of Lisle .... 780·94 ft.

Table I. must be used by extracting from it the difference of elevation in feet which it shows between the readings at the upper and lower stations.

If the precautions detailed in these notes are observed, aneroids, if of the best construction, will, subject to their natural limitations, give fairly satisfactory results.

Table I.—Guyot's Reductions of Barometric Readings to Feet. (From Smithsonian Miscellaneous Contributions.)

Barometer in inches.	Hundredths of an inch. ·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	Barometer in inches.
24·0	22873·0	22883·9	22894·7	22905·6	22916·5	22927·4	22938·2	22949·1	22960·0	22970·8	24·0
24·1	22981·7	22992·5	23003·3	23014·2	23025·0	23035·8	23046·6	23057·5	23068·3	23079·1	24·1
24·2	23089·9	23100·7	23111·4	23122·2	23133·0	23143·8	23154·5	23165·3	23176·1	23186·8	24·2
24·3	23197·6	23208·3	23219·1	23229·8	23240·5	23251·3	23262·0	23272·7	23283·4	23294·2	24·3
24·4	23304·9	23315·6	23326·3	23337·0	23347·6	23358·3	23369·0	23379·7	23390·3	23401·0	24·4
24·5	23411·7	23422·3	23433·0	23443·7	23454·3	23464·9	23475·6	23486·2	23496·8	23507·4	24·5
24·6	23518·1	23528·7	23539·3	23549·9	23560·5	23571·1	23581·7	23592·3	23602·9	23613·5	24·6
24·7	23624·1	23634·6	23645·2	23655·8	23666·3	23676·9	23687·5	23698·0	23708·6	23719·1	24·7
24·8	23729·7	23740·2	23750·7	23761·2	23771·7	23782·3	23792·8	23803·3	23813·8	23824·3	24·8
24·9	23834·8	23845·3	23855·7	23866·2	23876·7	23887·2	23897·7	23908·2	23918·6	23929·1	24·9
25·0	23939·5	23949·9	23960·4	23970·8	23981·3	23991·7	24002·1	24012·5	24023·0	24033·4	25·0
25·1	24043·8	24054·2	24064·6	24075·0	24085·4	24095·7	24106·1	24116·5	24126·9	24137·2	25·1
25·2	24147·6	24158·0	24168·3	24178·7	24189·0	24199·4	24209·7	24220·1	24230·4	24240·8	25·2
25·3	24251·1	24261·4	24271·8	24282·1	24292·4	24302·7	24313·0	24323·3	24333·3	24343·9	25·3
25·4	24354·2	24364·5	24374·7	24385·0	24395·3	24405·5	24415·8	24436·1	24436·3	24446·6	25·4
25·5	24456·8	24467·0	24477·3	24487·5	24497·8	24508·0	24518·2	24528·4	24538·7	24548·9	25·5
25·6	24559·1	24569·3	24579·5	24589·7	24599·9	24610·0	24620·2	24630·4	24640·6	24650·7	25·6
25·7	24660·9	24671·1	24681·2	24691·4	24701·5	24711·7	24721·8	24732·0	24742·1	24752·3	25·7
25·8	24762·4	24772·5	24782·6	24792·8	24802·9	24813·0	24823·1	24833·2	24843·3	24853·4	25·8
25·9	24863·5	24873·6	24883·7	24893·7	24903·8	24913·9	24921·0	24934·0	24944·1	24944·1	25·9

26·0	24964·2	24974·2	24984·3	24994·3	25004·4	25014·4	25024·4	25034·4	25044·5	25054·5	26·0
26·1	25064·5	25074·5	25084·5	25094·5	25104·5	25114·5	25124·5	25134·5	25144·4	25154·4	26·1
26·2	25164·4	25174·4	25184·3	25194·3	25204·2	25214·2	25224·1	25234·1	25244·0	25254·0	26·2
26·3	25263·9	25273·8	25283·8	25293·7	25303·6	25313·5	25323·4	25333·3	25343·2	25353·1	26·3
26·4	25363·0	25372·9	25382·8	25392·7	25402·6	25412·4	24522·3	25432·2	25442·1	25451·9	26·4
26·5	25461·8	25471·7	25481·5	25491·4	25501·2	25511·0	25520·9	25530·7	25540·5	25550·4	26·5
26·6	25560·2	25570·0	25579·8	25589·7	25599·5	25609·3	25619·1	25628·9	25638·7	25648·5	26·6
26·7	25658·3	25688·1	25677·8	25687·6	25697·4	25707·1	25716·9	25726·7	25736·4	25746·2	26·7
26·8	25755·0	25765·6	25775·4	25785·1	25794·8	25804·6	25814·3	25824·0	25833·8	25843·5	26·8
26·9	25853·2	25862·9	25872·6	25882·2	25892·0	25901·7	25911·4	25921·1	25930·8	25940·5	26·9
27·0	25950·2	25959·9	25969·6	25979·2	25988·9	25998·6	26008·2	26017·9	26027·5	26037·2	27·0
27·1	26046·8	26056·5	26066·1	26075·7	26085·3	26095·0	26104·6	26114·2	26123·8	26133·4	27·1
27·2	26143·0	26152·6	26162·2	26171·8	26181·4	26191·0	26200·6	26210·2	26219·8	26229·3	27·2
27·3	26238·9	26248·0	26258·0	26267·6	26277·2	26286·7	26296·3	26305·8	26315·3	26324·9	27·3
27·4	26334·4	26344·0	26353·5	26363·0	26372·4	26382·1	26391·6	26401·1	26410·6	26420·1	27·4
27·5	26429·6	26439·1	26448·6	26458·1	26467·6	26477·1	26486·5	26496·0	26505·5	26514·9	27·5
27·6	26524·4	26533·9	26543·3	26552·8	26562·3	26571·7	26581·2	26590·6	26600·0	26609·5	27·6
27·7	26618·9	26628·4	26637·8	26647·2	26656·7	26666·1	26675·5	26684·9	26694·3	26703·7	27·7
27·8	26713·1	26722·5	26731·9	26741·3	26750·7	26760·1	26769·5	26778·8	26788·2	26797·6	27·8
27·9	26806·9	26816·3	26825·6	26835·0	26844·3	26853·7	26863·0	26872·3	26881·7	26891·0	27·9
28·0	26900·4	26909·7	26919·0	26928·4	26937·7	26947·0	26956·3	26965·6	26975·0	26984·3	28·0
28·1	26993·6	27002·9	27012·2	27021·5	27030·7	27040·0	27049·3	27059·6	27067·8	27077·1	28·1
28·2	27086·4	27095·6	27104·9	27114·2	27123·4	27132·7	27141·9	27151·2	27160·4	27169·6	28·2
28·3	27178·9	27188·1	27197·3	27206·5	27215·7	27225·0	27234·2	27243·4	27252·6	27261·8	28·3
28·4	27271·0	27280·2	27289·4	27298·6	27307·8	27317·0	27326·2	27355·3	27344·5	27353·7	28·4
28·5	27362·0	27372·0	27381·2	27390·4	27399·5	27408·7	27417·8	27427·0	27436·1	27445·2	28·5
28·6	27454·4	27463·5	27472·6	27481·8	27490·9	27500·0	27509·1	27518·2	27527·4	27536·5	28·6
28·7	27545·4	27554·7	27563·8	27572·9	27582·7	27591·1	27600·2	27609·3	27618·3	27627·4	28·7
28·8	27636·5	27645·5	27654·6	27663·7	27672·7	27681·8	27690·8	27699·9	27708·9	27717·9	28·8
28·9	27727·0	27736·0	27745·1	27754·1	27763·1	27772·2	27781·2	27790·2	27799·2	27808·3	28·9

TABLE I.—Guyot's Reductions of Barometric Readings to Feet—continued.

Barometer in inches.	Hundredths of an inch.										Barometer in inches.
	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	
29·0	27817·2	27826·2	27835·2	27844·2	27853·2	27862·2	27871·2	27880·2	27889·1	27898·1	29·0
29·1	27907·1	27916·1	27925·0	27934·0	27943·0	27951·9	27960·9	27969·8	27978·8	27987·7	29·1
29·2	27996·7	28005·6	28014·6	28023·5	28032·4	28041·4	28050·3	28059·2	28068·2	28077·1	29·2
29·3	28086·0	28094·9	28103·8	28112·8	28121·7	28130·6	28139·5	28148·4	28157·3	28166·2	29·3
29·4	28175·1	28184·0	28192·9	28201·7	28210·6	28219·5	28228·4	28237·2	28246·1	28254·9	29·4
29·5	28263·8	28272·6	28281·5	28290·3	28299·2	28308·0	28316·9	28325·7	28334·5	28343·4	29·5
29·6	28352·2	28361·0	28369·8	28378·7	28387·5	28396·3	28405·1	28413·9	28422·7	28431·5	29·6
29·7	28440·3	28449·1	28457·9	28466·7	28475·4	28484·2	28493·0	28501·8	28510·6	28519·3	29·7
29·8	28528·1	28536·9	28545·6	28544·4	28563·2	28571·9	28580·7	28589·4	28598·2	28606·9	29·8
29·9	28615·7	28624·4	28633·2	28641·9	28650·6	28659·3	28668·1	28676·8	28685·2	28694·2	29·9
30·0	28702·9	28711·6	28720·3	28729·0	28837·7	28746·4	28755·1	28763·8	28772·5	28781·1	30·0
30·1	28789·8	28798·5	28807·2	28815·9	28824·5	28833·2	28841·9	28850·5	28859·2	28867·9	30·1
30·2	28876·5	28885·2	28893·8	28902·5	28911·1	28919·8	28928·4	28937·0	28945·7	28954·3	30·2
30·3	28962·9	28971·5	28980·1	28988·8	28997·4	29006·0	29014·6	29023·2	29031·7	29040·3	30·3
30·4	29048·9	29057·5	29066·1	29074·7	29083·3	29091·8	29100·4	29109·0	29117·6	29126·2	30·4
30·5	29134·7	29143·3	29151·9	29160·4	29169·0	29177·6	29186·1	29194·7	29203·2	29211·8	30·5
30·6	29220·3	29228·9	29237·4	29245·9	29254·4	29262·9	29271·5	29280·0	29288·5	29297·0	30·6
30·7	29305·5	29314·0	29322·5	29331·1	29339·6	29348·1	29356·6	29365·1	29373·5	29382·0	30·7
30·8	29390·5	29399·0	29407·5	29416·0	29424·4	29432·9	29441·4	29449·8	29458·3	29466·8	30·8
30·9	29475·2	29483·7	29492·1	29500·6	29509·0	29517·5	29525·9	29534·3	29542·8	29551·2	30·9

TABLE II.—Multipliers for Temperature of Intermediate Air.

Mean Temperature of Intermediate Air.	Multiplier	Mean Temperature of Intermediate Air.	Multiplier.	Mean Temperature of Intermediate Air.	Multiplier.
32°... ...	1·0000	55°... ...	1·0511	78°... ...	1·1022
33°... ...	1·0022	56°... ...	1·0533	79°... ...	1·1044
34°... ...	1·0044	57°... ...	1·0555	80°... ...	1·1066
35°... ...	1·0066	58°... ...	1·0577	81°... ...	1·1088
36°... ...	1·0088	59°... ...	1·0599	82°... ...	1·1111
37°... ...	1·0110	60°... ...	1·0622	83°... ...	1·1133
38°... ...	1·0133	61°... ...	1·0644	84°... ...	1·1155
39°... ...	1·0155	62°... ...	1·0666	85°... ...	1·1177
40°... ...	1·0177	63°... ...	1·0688	86°... ...	1·1199
41°... ...	1·0199	64°... ...	1·0711	87°... ...	1·1222
42°... ...	1·0222	65°... ...	1·0733	88°... ...	1·1244
43°... ...	1·0244	66°... ...	1·0755	89°... ...	1·1266
44°... ...	1·0266	67°... ...	1·0777	90°... ...	1·1288
45°... ...	1·0288	68°... ...	1·0799	91°... ...	1·1311
46°... ...	1·0311	69°... ...	1·0822	92°... ...	1·1333
47°... ...	1·0333	70°... ...	1·0844	93°... ...	1·1355
48°... ...	1·0355	71°... ...	1·0866	94°... ...	1·1377
49°... ...	1·0377	72°... ...	1·0888	95°... ...	1·1399
50°... ...	1·0399	73°... ...	1·0911	96°... ...	1·1422
51°... ...	1·0422	74°... ...	1·0933	97°... ...	1·1444
52°... ...	1·0444	75°... ...	1·0955	98°... ...	1·1466
53°... ...	1·0466	76°... ...	1·0977	99°... ...	1·1488
54°... ...	1·0488	77°... ...	1·0999	100°... ...	1·1511

ABLE III.—Correction for the Decrease of Gravity o Vertical acting on the Density of the Air. This cor tion must be added :—

(From Smithsonian Miscellaneous Contributions.)

Approximate Difference of Level.	Decrease of Gravity. Positive.	
	0	+ 500
Feet.	Feet.	Feet.
1000	2·5	3·9
2000	5·2	6·6
3000	7·9	9·3
4000	10·8	12·2
5000	13·7	15·2
6000	16·7	18·3
7000	19·9	21·5
8000	23·1	24·7
9000	26·4	28·1
10,000	29·8	31·5

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

TABLE II.—Multipliers for Temperature of Intermediate Air.

Mean Temperature of Intermediate Air.	Multiplier	Mean Temperature of Intermediate Air.	Multiplier.	Mean Temperature of Intermediate Air.	Multiplier.
32°... ...	1·0000	55°... ...	1·0511	78°... ...	1·1022
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40°... ...	1·0177	63°... ...	1·0688	86°... ...	1·1199
41°... ...	1·0199	64°... ...	1·0711	87°... ...	1·1222
42°... ...	1·0222	65°... ...	1·0733	88°... ...	1·1244
43°... ...	1·0244	66°... ...	1·0755	89°... ...	1·1266
44°... ...	1·0266	67°... ...	1·0777	90°... ...	1·1288
45°... ...	1·0288	68°... ...	1·0799	91°... ...	1·1311
46°... ...	1·0311	69°... ...	1·0822	92°... ...	1·1333
47°... ...	1·0333	70°... ...	1·0844	93°... ...	1·1355
48°... ...	1·0355	71°... ...	1·0866	94°... ...	1·1377
49°... ...	1·0377	72°... ...	1·0888	95°... ...	1·1399
50°... ...	1·0399	73°... ...	1·0911	96°... ...	1·1422
51°... ...	1·0422	74°... ...	1·0933	97°... ...	1·1444
52°... ...	1·0444	75°... ...	1·0955	98°... ...	1·1466
53°... ...	1·0466	76°... ...	1·0977	99°... ...	1·1488
54°... ...	1·0488	77°... ...	1·0999	100°... ...	1·1511

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Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 5

Gunn's Plains, Alma, & other Mining Fields, North-West Coast

BY

W. H. TWELVETREES

Government Geologist

Issued under the authority of the [illegible]

HOBART:
JOHN VAIL, GOVERNMENT PRINTER

1909

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TABLE OF CONTENTS.

PAGE

I.—INTRODUCTION ... 1

II.—PREVIOUS LITERATURE ... 2

III.—PHYSIOGRAPHY ... 4

IV.—GEOLOGY.

- (1) Pre-Cambrian ... 5
- (2) Cambrian ... 7
- (3) Cambro-Ordovician ... 8
- (4) Ordovician ... 10
- (5) Igneous Rocks ... 11
  - (*a*) Porphyroids ... 11
  - (*b*) Serpentine ... 15
  - (*c*) Granite ... 15
  - (*d*) Basalt ... 16

V.—MINING PROPERTIES.

- (A) Copper Creek Mine ... 17
- (B) Radford's Reef ... 22
- (C) Brown's Blow ... 23
- (D) Colbourn's Mine ... 23
- (E) Heazlewood's Silver Mine ... 23
- (F) Preston Silver Mine ... 24
- (G) Rutherford Copper Mine ... 24
- (H) Clark's Lode ... 27
- (I) Alma Mine ... 27
- (J) Lucas and Perry's Lodes ... 33
- (K) Crawford's Lodes ... 33

VI.—RAILTON DISTRICT.

- (A) Tune's Reef ... 36

VII.—CONCLUSION ... 37

PLATES.

I.—Geological Traverse of the Leven Gorge ... } At end
II.—Geological Section of Country at Railton ... } of Report

GUNN'S PLAINS, ALMA, AND OTHER MINING FIELDS, NORTH-WEST COAST.

I.—INTRODUCTION.

ATTENTION has been lately directed to some copper ore properties situate up the Leven and Forth Rivers, and these ore deposits having some bearing on the question of railway facilities now under discussion, it was deemed advisable to make a geological examination of the localities and ascertain the prospects of any mineral output which would contribute in any way to the traffic on the proposed line to Castra.

The examination was considered also as likely to be of use in elucidating further the geology of the North-West Coast, as up to the present not much has been definitely known with respect to the sequence of the strata, more especially as regards the position of the copper-bearing beds in the geological record.

Copper and silver-lead ore veins are being frequently discovered (in many instances rediscovered would be the more appropriate term) in the older rocks which have been cut down into the creeks and rivers, but none of these occurrences have so far been shown by actual work to be of any great importance. Some of them have been worked and abandoned as soon as the ore-shoot pinched, and as a result a feeling of uncertainty has developed as to the outlook and the possibilities of these fields. Some information seems to be necessary in regard to the correlation of the ore-deposits with those in other parts of the island, and their probable permanence. The geological age of the enclosing strata is a question which of necessity has hitherto remained unsettled, and it is quite time that some attention should be paid to it. Economic geology and general geology are indissolubly connected, and if one is pursued to the total exclusion of the other, results of work cannot be illuminating and informative, while the State eventually must inevitably suffer reproach.

For the last 18 months some work has been carried on at Gunn's Plains, 12 miles from Ulverstone, by the Copper

Creek Mining Company, and as the Public Works Commissioners have strongly recommended the construction of a line of railway from Ulverstone through the Plains, under the provisions of "The Local Government (Tramways) Act, 1907," mining enterprise in the district merits consideration. Some other ore outcrops occur along the Leven River, which may in time receive attention. Some of the known copper ore occurrences on the east flank of the Dial Range may also receive a stimulus when this tramway is built. A little silver-lead prospecting at South Preston likewise indicates the existence of mineral-bearing country within range of the proposed railway.

Mineral country also exists between the Wilmot and Forth Rivers, a short distance above their confluence. West of the Forth is the old Barrington Copper Mine, on which the Alma Prospecting Syndicate has recently resumed work. Deposits of barytes occur on this property.

Westwards, between the Blythe and Emu Rivers, is a line of copper and iron ore deposits, tried for copper ore by the Burnie Copper Company and the Rutherford Company somewhat inconclusively. The former company would doubtless have proved its lode to a greater depth but for losses in other parts of Tasmania. The Rutherford lode remains to be tested. The noted iron ore lode of the Blythe is in this belt.

This coastal country, largely covered with basaltic soil and occupied by agriculturists, unquestionably possesses mineral lodes which indicate possibilities and appeal legitimately to mining enterprise. The points at which mineral appears are, however, somewhat scattered, and this renders the work of fixing the relationships of the deposits and making comparisons a little difficult, for the area under review is wide and broken.

The limestone beds on the Coast, too, are of importance. Good limestone occurs at Railton, the Don, Gunn's Plains, and the same stone is known at the Blythe River. These beds are destined to be greatly exploited as population increases, both for building and agricultural purposes.

II.—PREVIOUS LITERATURE.

Official reports on various parts of the Coast have been issued from time to time by the Government of Tasmania.

In a report by Mr. G. Thureau, Government Geologist, on the North-Western mineral deposits, dated 30th December, 1881, reference is made to quartz reefs up the Castra-road, S.S.E. from Ulverstone, and to the Barrington Copper Mine, near Alma. Mr. Thureau describes Reid's reef as cropping out at the side of a gulley emptying into the Clayton Rivulet: "This reef observes a strike of W. 3° N., and the strata in which it is embedded of N. 38° W. It is a very massive one, being over 15 feet wide at the surface, with a northern underlay of 65°. The quartz is hard, coarsely laminated, and reddish in colour near the surface; where the stone has been followed beneath the surface it assumes a bluish hue, owing to the presence of crystalline iron pyrites . . . The tunnel intersected the reef at a distance of 60 feet from its mouth, and the quartz broken down exhibits a more favourable appearance."

At this time the Barrington tunnel was "driven in a north-westerly direction to a length of 281 feet. Two crosscuts extend from this tunnel to the west for a length of 33 feet and 32 feet respectively."

Mr. A. Montgomery, Government Geologist, in his report on the Gawler River, &c., of the 29th July, 1895, described a visit to a gold-bearing reef which had been discovered about 2 miles from Ulverstone: "The lode consists of from 8 to 12 inches thickness of quartz and some 6 inches of clay, the latter being on the walls. The quartz has a vitreous appearance, and contains a good deal of iron pyrites, with a little copper pyrites and blende. Strike about W.N.W. and E.S.E., dip 67° to the northward. . . . Several prospects washed from the quartz gave very poor results, though a little gold was seen, and it would appear that the reef is auriferous, but as yet nothing like payable. It might, however, be prospected with advantage, and should be traced both east and west along its strike, and tested at intervals to find if its gold contents increase. . . . From time to time it has been reported that a little gold occurs in the Gawler Range itself. . . . Though nothing of much consequence has yet been found, it seems probable that the locality is of a favourable nature for minerals, more especially gold, and is therefore worth some attention from prospectors."

The writer, in his report on the Dial Range, 19th December, 1903, described some of the copper ore formations on Walloa Creek, and his report on North-West Coast mineral deposits, 26th July, 1905, included an account of the Barrington Mine at Alma.

III.—PHYSIOGRAPHY.

This part of the North Coast is a raised peneplain dissected by river systems, the waters of which are discharged into Bass Straits. Two fine rivers—the Leven, at Ulverstone; and the Forth, at Leith—empty into the sea at those places, having their sources far away in the interior in the high land near Mt. Pelion, and west of the Middlesex Plains. These rivers, with their tributaries, have cut deep channels through the basaltic covering of the tableland, through the sub-basaltic gravels, and down into the underlying ancient rocks, with the result that sections of the latter are frequently well exposed in the banks of the valleys or walls of the river gorges. Each of the rivers named has an estuarine expansion at its mouth, and the adjoining flats occupying the township areas have only emerged from the sea within the Recent period. The Leven, at 10 miles south of Ulverstone, is not more than 150 feet above sea-level, while the surrounding plateau has risen to between 700 and 900 feet.

The town of Ulverstone is situated at the mouth of the River Leven, on both banks. This thriving town is in a picturesque position, commanding striking views of the Dial Range to the west, the gnomon of the dial being a prominent feature. The flat ground extends back from the sea for nearly a mile, and then the land rises to form the table-land, the soil of which nourishes the potatoes and other root crops for which this coast is famous. Various gorges and romantic river reaches occur at intervals along the course of the stream. At the south end of the reserved township of Leven the road passes alongside the river through a charming ravine for 2 miles, winding round the base of the Sugar Loaf before it emerges on Gunn's Plains—an open, hill-locked valley, 5 miles in length from north to south. The alluvial soil which forms the floor of this valley is highly suitable for agriculture, fruitgrowing, and dairying. The Public Works Commissioners, in reporting on railway facilities for the Castra District, and recommending the construction of the line through Gunn's Plains and Preston to Blackwood Park, say:—"Gunn's Plains have an area of 9040 acres, mostly rich agricultural soil, of which 697 acres have been under cultivation this year (1908); 1300 acres have been cultivated, and are now in grass; 5543 acres are in rough grass; and 1500 acres in scrub. The produce this year has totalled 2092 tons."

The River Leven keeps to the west side of the Plains, having probably cut its channel from time to time further and further west. The bed-rock underlying the alluvial bottom is limestone, and the open valley which constitutes the plains probably owes its formation to this. After the river has traversed the limestone belt and enters the hard conglomerates and igneous rock area, the plain contracts to a narrow ravine, the only available outlet for the river. The massive rocks of the Dial Range system are responsible for many windings of the stream on its way to the sea.

A good carriage-road exists from Ulverstone to the Plains. After attaining an altitude of 700 feet above sea-level it descends through Leven for 500 feet in a couple of miles to the farms on the river.

IV.—GEOLOGY.

The rock-types developed on the North-West Coast are of somewhat numerous varieties. They have, so far, been imperfectly examined, and offer a fine and comparatively untouched field for geological study. Students may usefully devote time to the examination of the different rock-exposures on the sea-coast, and to following up the geology inland.

The geological sequence and the rocks observed near Ulverstone and the Forth will first be dealt with, and some outlying occurrences also referred to.

(1)—PRE-CAMBRIAN STRATA.

These are strongly developed at Ulverstone, and deserve attention, as being the floor on which the whole superstructure of our Cambrian and Post-Cambrian sediments rests. We have not yet succeeded in obtaining evidence of the existence at surface in Tasmania of rocks really belonging to the Archæan complex. The oldest rocks which have been found are those dominantly sedimentary foliated strata which belong to the Upper Pre-Cambrian. The United States Geological Survey has separated these sedimentaries from the igneous Archæan complex below, and termed them Algonkian. Chamberlin and Salisbury, the American geologists, have designated them Proterozoic, reserving the title Archæozoic for the great granitoid and schist series of the Archæan. It is these Algonkian schistose quartzites and micaceous schists which occupy so large an area in the western part of Tasmania. They constitute the headlands which project into the sea at Cox's Bight and Port Davey, and form the mountain ranges generally in the south-west of the island. They form a large block of country west of the Denison Range and the Thumbs, and comprise a good deal of the high land at the head of the Forth. The quartzite at Rocky Cape and Sisters belongs to this division, as also the micaceous schists of the lower Forth. Further east the group is represented by the schists of the Asbestos Range.

The bearing of these strata does not diverge much from north and south, and is mostly a few degrees east of north. At Ulverstone, on the East Beach, they are exposed in long lines at low tide, running out northerly into the sea, and dipping steeply to the west. At Picnic Point, on the West Beach, they strike N. 20° E., with a north-westerly dip. Going west they crop out occasionally in the sand, but are shown strongly at Goat Island. In the bay west of this island they are covered by Tertiary basalt, and on the beach opposite Barkworth's are succeeded by drab slates. The last strike of the schistose conglomerate west of Goat Island is N. 10° W., while the slates of the succeeding systems strike N. 20° W. The junction of the Cambrian and Pre-Cambrian strata is here unfortunately concealed by the basalt lava flow.

The rocks composing this system are schistose quartzites or quartzitic schists, sericite schists, and schistose conglomerate. All these represent rocks originally sandstone and conglomerate, with, perhaps, some shale or argillaceous beds. Sometimes the metamorphic process has not been intense enough to obliterate the original granular texture; at other times the deforming forces have produced a development of the silky, filmy mica known as sericite, which coats the folia of the schist and causes the rock to become a sericitic quartzite schist or a sericitic schist. Some of the schistose conglomerates show beautiful examples of stretched quartz pebbles. Thousands of these pebbles may be seen stretched by rock movements several inches in length without breaking, and bent in conformity with the curves in the schist. When crowded together they often present the appearance of drawn-out strings of quartz, forming a purely quartz schist.

The Algonkian sediments have resulted from the mature decomposition of still more ancient rocks, either Lower Algonkians or Archæan. The earlier systems have not been yet identified in the island. As matters stand at present, these schists are the oldest which are known to us, and spread, as they are, over so large an area of Tasmania, thicknesses are involved which denote an enormous period of time during which this sedimentation proceeded.

They are seen in a quarry three-quarters of a mile south of Ulverstone, up the North Motton-road, where the land rises to form the plateaux; but are concealed from view at Gunn's Plains, even though the height there above sea-level is inconsiderable. They are also prevalent in the Forth Valley, south of Hamilton. There was evidently a Pre-Cambriàn schist-forming period in Tasmania, because the Cambrian sandstones and slates are not schistose.

The quartz, which is abundant in the schists, is not in the form of reefs, but seems to occur generally as segregation veins and irregular patches and strings, without any economic mineral. Considering, however, the proximity of the intrusive granite to the coast-line, there is no apparent reason why the schists should not prove to be the receptacles of ores, as they must have been invaded at various points by the granitic metal-bearing magmas.

(2)—CAMBRIAN.

The only certain exposures of rocks belonging to this period in Tasmania are between Railton and Latrobe in the north, and at the Humboldt Divide and in the Florentine Valley in the south.

The Caroline Creek beds near Railton have furnished fossils which have been identified by Mr. Robt. Etheridge as representing the genera Ptychoparia, Dikelocephalus, Asaphus, and Ophileta. Mr. Etheridge states that it is more than probable that the age is "that of the Lingula flags or Menevian beds of Great Britain, and the Potsdam sandstone of North America.*.

Sandstones on the north flank of Mt. Stephens, at the head of the Florentine Valley, have yielded imprints of Dikelocephalus which Mr. Etheridge has named D. florentinensis.

By general consent the upper limit of the Dikelocephalus fauna is considered as the upper limit of the Cambrian system; and at Railton a fortunate exposure at Mr. Blenkhorn's quarry shows the Dikelocephalus sandstone passing (apparently conformably) below the Lower Silurian limestone (Gordon River series).† The uppermost Cambrian beds consist of cavernous argillaceous strata, containing indistinct fossils. These are exposed at the abovementioned quarry for a width of about 6 feet, and are underlaid by the Dikelocephalus sandstone beds, which pass downwards into chocolate-coloured clay slates and thinly-bedded sandstones and pebbly grits. The whole series continues north-west from the quarry along the Latrobe-road, crossing the railway-line at the bridge over Caroline Creek, about 4 miles from Railton. The dip is uniformly south-westerly. At the bridge the strata appear in the railway-cutting as chocolate-coloured sandstones, dipping at an angle of about 30°. On the bank here fragmentary and ill-preserved remains of trilobites may be collected after a little search. Boulders of yellow friable sandstone seem to be the home of most of the fossils.

---

* Proc. Roy. Soc. Tas., 1882, p. 158.

† On this occasion I collected from the Dikelocephalus beds at the quarry a fragment of a trilobite, recognised by Mr. Etheridge as Ptychoparia stephensi (formerly known as Conocephalites stephensi).

In the Railton township yellowish slates, sandstones, and coarse grits are exposed near the Wesleyan Church, the latter carrying impressions of univalves, considered by Mr. Etheridge as belonging to the genus Raphistoma. The strata are steeply inclined, sometimes vertical, but on the whole dipping to the N.E.

The Railton exposures of Cambrian strata correspond with similar exposures on the Humboldt Divide, where the trilobite sandstone underlies the Gordon River limestone and passes down into chocolate-coloured slates near the Humboldt Mine.

At Gunn's Plains the limestone rests upon a series of cherty conglomerates, breccias, tuffs, and chocolate-coloured slates, which are probably of Cambrian age. The yellow fossiliferous sandstones of Caroline Creek, however, appear to be absent there, and until further evidence is available, it is perhaps safer to use the indefinite term Cambro-Ordovician for this breccia-slate system.

(3)—CAMBRO-ORDOVICIAN.

At Gunn's Plains, the northern boundary of the Gordon River limestone (Ordovician) is seen on the west side of Walloa (Copper) Creek, in the block charted in the name of C. J. Kent. Its strike is N.W.-S.E., and dip S.W. The cherty conglomerates of the Sugar Loaf Gorge and the Copper Creek country pass below the limestone at a high angle.

The accompanying map shows the remarkable development of the conglomerate series as exposed along the Leven River for a couple of miles from the Plains. The whole series has a N.W.-S.E. strike, with a south-westerly dip.

The ravine of the river intersects numerous parallel belts of conglomerate, breccia, slate, and tuff, alternating in rapid succession and interrupted at intervals by dykes or other intrusions of igneous rock.

The conglomerate is characterised by three marked features. Its texture on the whole is fine or medium-grained. The pebbles have a tendency to become angular in form, the rock assuming the nature of a breccia; and the dominant components are not quartz pebbles, but stones or fragments of chocolate-coloured or greenish cherty slate. These characters produce a lithological *tout ensemble*, which invariably makes the recognition of this series easy, in whichever part of the island it may occur. It may be remarked *en passant* that they distinguish it from the variety of the West Coast conglomerate familiar on the mountain ranges north and south of Mt. Lyell. It is identical with the fine-grained breccias which are exposed on the coast-line east of Lodder's Point and at the Neptune Mine. The breccias tend to become gossanous and pyritiferous, and either to enclose patches of igneous rock or to be subject to intrusions of same. They are themselves largely tuffaceous. This association with tuffs and intrusive rocks will be referred to subsequently in this report.

The same series of purple, green, and black slates continue west to the mining sections on Copper Creek, alternating there also with conglomerate and breccia. Opposite Mr. E. Wing's house, at the north end of the gorge, black slate crosses the bed of the Leven, and probably exists below the flat land of the valley there. Where the road turns to ascend the Leven Hill it intersects a band of conglomerate, and thereafter is in igneous rock of the porphyroid group right up to the level of the plateau.

These Cambro-Ordovician strata extend east and west below the basaltic covering of the North-West Coast, interrupted at intervals by intrusions of porphyroid, serpentine, and granite. They are exposed at Stowport, between the Emu and Blythe Rivers, and at the Blythe Iron Mines. Here, however, they strike N.E.-S.W., and dip S.E. The same geological succession appears to prevail as at Gunn's Plains. The limestone rests upon the older series on E. Addison's 31 acres, No. 9336, west of the Blythe Bridge. Although the underlying rocks are greatly concealed by the overlying basalt, enough can be seen to establish the occurrence of conglomerate between the limestone and the slate strata. The conglomerate is visible on the main-road, east of the Blythe iron lode, on O. Allen's land, and descends south-westerly to the Blythe River, where it constitutes the hanging-wall country of the iron lode. Two miles further south it emerges on the 320 acres, (T. S. Rutherford), east of the iron lode on that property. The copper-bearing strata west of this line are those in which the Burnie and Rutherford Mines have been worked. The ascending sequence is accordingly—(1) Copper-bearing slates. (2) Conglomerate. (3) Limestone.

At Alma a succession of copper-bearing slates, conglomerates, and breccia also occurs, but no definite datum-line for deducing their geological horizon-line has been found. The limestone is absent, but schists occur on the Forth River further north, and these are assumed to be Pre-Cambrian. The Alma strata are, therefore, probably Cambrian or Cambro-Ordovician. They are associated with porphyroids, and may be taken as members of the same system as the copper-bearing series at Gunn's Plains. It must be borne in mind that the term Cambro-Ordovician is only provisional. It is extremely probable that later research will make it necessary to transfer many of these strata to the Cambrian.

Mr. L. K. Ward, after examining the slate series of the Dundas field and the brecciated conglomerates there, and comparing same with the above observations, and my specimens from the North-West Coast, correlates these strata in both districts as belonging to one system.

The task remaining for the survey is to establish the exact geological position of the breccia slate series, *i.e.*, to determine whether it is higher in the record than the Dikelocephalus sandstone or whether it occupies a lower horizon in the Cambrian. At Gunn's Plains it is immeddiately below the limestone; at Lodder's Point it succeeds the Pre-Cambrian schists.

(4)—ORDOVICIAN.

The limestone occupies the floor of the Gunn's Plains Valley from north to south, bearing in a N.W.-S.E. direction, and dipping S.W. It would thus have an observed width of about 5 miles, and its strike, if prolonged S.E., would take it into the Mole Creek district. Its first appearance on the Plains is on the west bank of Copper Creek, at Mr. Wells' farm, where it comes down from Kent's land on the hill. It occupies the slope of the hills on the west side of the Leven River, and has a similar position on the east side of the Plains. It is sparsely fossiliferous, and the fossils are generally replaced by calcite. However, a few imprints of a small Orthis are occasionally obtainable. It undeniably belongs to the Mole Creek and Gordon River series.

A small lime-burning industry exists at the Plains, and the lime, which is of excellent quality, finds a ready sale at Ulverstone at 2s. per bushel bag. The stone is also used for metalling roads at the Plains.

Caves have been known and visited for some time at the Plains, but until recently they have not attracted attention. Those on the west side of the Leven are not of a striking character, but the cave on the Limestone Reserve on the east side of the valley, officially opened this month by the Hon. the Premier, possesses spectacular merits which make it an undoubted asset from the tourist point of view. It deserves to be opened up on a still larger scale.

(5)—IGNEOUS ROCKS.

(a)—*Porphyroids.*

Ancient igneous rocks are strongly developed in the Leven Basin near Gunn's Plains. Along the course of the Leven River after it issues from the Plains various members of the Porphyroid complex are exposed. This complex comprises a series of dynamically affected quartz and felspar porphyries represented elsewhere in Tasmania at Mts. Farrell, Lyell, Jukes, Darwin, and other points on the West Coast Range. They range from distinctly acid types through subacid to rather basic varieties. The latter are characterised by abundance of pyroxene and comparative poverty in quartz.

A remarkable series of bedded tuffs is seen exposed for 400 feet along the roadside south of Hampton's cottage, in the Sugar Loaf Gorge. These are evidently contemporaneous with the conglomerate and slate, and are perhaps the oldest directly igneous rocks known in Tasmania.

These are soft, short-jointed, light-grey rocks, dotted with numerous specks of kaolin, yielding forms of felspars, which are usually lost in preparing slides for microscopical examination. Under the microscope the base appears as a pellucid glass, with numerous vesicular steam cavities. In this base is a confused groundmass of particles of ash and felspar microlites, with occasional grains and nests of quartz. It is evidently an acid tuff, and its position, interbedded with the slate and conglomerate series, points to a much higher antiquity of the porphyroid complex than has hitherto been ascribed to it.

The next members of the series to be considered are the clastoporphyroids. These are brecciated rocks, often gossanous, and enclosing irregular tuffaceous patches, with an occasional sprinkling of pyrite. They are characteristically calcareous, but have a partially vitreous and felsitic base, with much quartz, some of it secondary. In part they are probably fragmental tuffs. These rocks are strongly developed north of Brown's cottage, and again further on the road towards Wing's. The forms of calcite seen microscopically in this rock are rather suggestive of being pseudomorphous after felspar. Porphyroidal rocks which have been derived from tuffs, as well as altered porphyroid tuffs, are known under the name of clastoporphyroids, and these irregularly fragmental igneous rocks seem to belong to that type.

East of Wells' farm are some low hills, north of the road, which appear to be composed of a reddish hornblendic porphyroid, also met with on the west side of the Leven in the Sugar Loaf Gorge. The same rock occurs on the Forth River at the Waterworks building intrusive in slates, with an exposure of two or three chains in width. Numerous stones of the same rock are to be seen in the shingle on the beach at Ulverstone.

It is a granophyric quartz-felspar porphyry, with most of its porphyritic felspars triclinic, and approximates to the quartz porphyrites. Besides the phenocrysts of felspar there are others of corroded quartz, and some imperfectly preserved forms of green hornblende. The groundmass is an aggregate of quartz and felspar in granophyric intergrowth.

On the west side of the Leven, opposite Hampton's cottage, is a bluff of rock belonging to this group. The groundmass is a quartz-felspar aggregate. The phenocrysts are quartz, felspar (mostly triclinic), and a few doubtful remnants of ferro-magnesian minerals. The quartz phenocrysts have angular fragmentary outlines or are embayed.

Not far from the south end of the Sugar Loaf Gorge the road intersects a band of bluish porphyroid between slate on either side, 75 feet wide. This is a siliceous variety, quartz phenocrysts being abundant. These are either angular or with corroded boundaries. Orthoclase and plagioclase felspars are the principal remaining phenocrysts. A few remnants of a light-green hornblende can be detected.

Besides the acid and sub-acid rocks referred to, more basic varieties occur, to which it is hardly possible to give definite names until they have been more closely examined. In the meantime, they are designated pyroxenic porphyroids. They are essentially augite-plagioclase rocks with accessory hornblende, biotite, or quartz. The presence of these accessories is taken to indicate relationship with the porphyroid group rather than with our diabase and basalt, which they otherwise recall. One variety of this type is seen at the point of the road south of E. Wing's house.

It is known locally as serpentine, owing to the development of asbestos on its joint-faces. It is very much decomposed, but the exposure along the roadside can be traced for 200 feet in width. On its south wall are conglomerate and breccia. Its north wall is concealed, but is probably slate, as the latter is exposed in the river opposite Mr. Wing's house.

Under the microscope the rock appears to consist of plagioclase felspar and augite, with accessory hornblende and biotite. Where there is any interstitial material in the groundmass, it is quartzo-felspathic, though it is doubtful to what extent the quartz is original. The idiomorphism of the augite is less than that of the felspars, the prisms of the latter frequently penetrating the forms of the pyroxene. To the naked eye the rock is dark, of granular texture, with no distinctive characteristics. It here evidently forms a dyke.

The next basic variety is the rock exposed in the roadside all the way up the Leven Hill from Clark's farm, 10 miles from Ulverstone. The general appearance, weathering, and occurrence, conform with those of a basaltic rock, and it might very well be mistaken for the usual Tertiary basalt of the North-West Coast. It contains, however, visible pyrite, and microscopical examination shows that there is a considerable quantity of granular quartz in its base. It is a plagioclase-augite porphyritic rock, with the augite crystals generally collected in nests, somewhat after the fashion known to petrologists as glomero-porphyritic. Microscopically, it shows signs of crushing, and must belong to the older rocks.

Future work on these rocks will show whether all of them can be included in the group which, using the term in a liberal sense, we are designating by the name of porphyroid. In Tasmanian geology the whole group bears the name of some of its most prominent members. Thus, strictly, porphyroid is dynamically-altered quartz-porphyry.

But in our quartz-porphyry complex we have a great variety of types, *e.g.*, granite, syenite, granophyres, felsites, porphyrites, quartz-diorite porphyrites, diorite porphyrites, and apparently some imperfectly understood more basic members.

The whole group at Gunn's Plains seem to be confined to the slate and conglomerate area, *i.e.*, infra limestone. Once the limestone country is entered upon, the porphyroid exposures are absent. Whether this is merely a coincidence or not is uncertain, but it is, to say the least, suggestive of the eruptive rock being older than the Ordovician limestone. The bedded tuffs certainly are older, but the other eruptives appear to be intrusive in the slates and conglomerates, and to have been dynamically affected in their own way as much as the slates have been in theirs. In this they differ from our Devonian granite, which is always uncrushed. The porphyroid group, therefore, must be Pre-Devonian. It seems to have been contemporaneous with the Cambro-Ordovician, and perhaps in part later than the lower members of the system.

In accordance with this view, we find the granite of which the porphyroids are modifications developed elsewhere in the island under conditions which point to it pre-dating our Devonian granite. Thus, on the Murchison River, Mt. Farrell, Mr. L. K. Ward (in his report on the Mt. Farrell field, Bulletin No. 3) mentions it as a medium-grained basic granite or syenite altered by dynamical stresses and merging into green porphyritic felsites. This is the rock that used to be called in Germany syenite-granite. In the Rosenbusch classification it would be termed amphibole-granitite, *i.e.*, a biotite granite containing hornblende. The hornblende varies in amount, and to its quantity, quartz and orthoclase (according to Rosenbusch) occur in inverse ratio, plagioclase directly, and the latter becomes more basic. In this way, complete passages to plagioclastic rocks are effected, on the one hand to the dioritic and tonalitic facies of granite, and to orthoclase rocks without quartz, or poor in it, on the other (the syenitic facies of granitite). In Tasmania, syenitic or dioritic modifications are frequent in connection with our porphyroidal granite.

Whether the Devonian is the only granite to which our ores are genetically related, or whether some of them are connected with the porphyroid series, is a question which is occupying the attention of the Survey, and cannot be definitely settled until more complete data are collected.

In any case the distribution of the latter group is acquiring increased importance in the geological scheme, and may prove to govern ore-deposition more directly than has been hitherto supposed.

An outcrop of porphyroid also occurs on the Alma Mine property, at the top of the hill above the mine works, where it forms a crag of hard projecting rock of reddish-brown colour.

(*b*)—*Serpentine.*

About ¾-mile south of the township of Hamilton, serpentine is exposed along the road, apparently for about a couple of hundred feet. It must extend to the north-west, as I am informed that it also occurs on Mrs. Jas. Smith's property at Westwood. Its boundaries are not clearly visible, but it seems to be between quartzite on the east and schistose, garnetiferous zoisite-amphibolite on the west. It is a handsome stone, and if any demand existed, could doubtless be worked for ornamental purposes.

Microscopic examination of it shows that the serpentinisation has proceeded pretty far. However, crystals of rhombic pyroxene can be clearly identified, and the forms of the other crystalline component (which is thoroughly serpentinised) point to this being olivine. The rock would accordingly be the olivine-enstatite peridotite known as harzburgite.

At surface it does not show any connection with gabbroid rock, and gabbro is not known in the vicinity, but the rock is, nevertheless, a product of the gabbroid magma. Rosenbusch, in his "Massige Gesteine,"* states:—"Peridotites and pyroxene rocks have no sovereign geological independence; they partake of the character of vassals, and in classification should be attached direct to the members of the gabbro family, of which they represent the non-felspathic forms."

Although at the Forth the serpentine appears not far from amphibolitic schist, no causal relationship has been established between the two at this spot.

(*c*)—*Granite.*

The granite of the Hampshire Hills and Housetop area extends northwards as far as the southern portion of the Rutherford Mine property between the Emu and Blythe Rivers, and its northern edge continues south-easterly across the intervening country to the southern boundary of Riana township. There is some granite also east of the Dial Range at Hardstaff's Mine, and there must be some also in the hill east of Copper Creek, as I picked up a piece in the bed of a small creek which flows east into the Leven at the Gorge.

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* 1907, I., p. 452.

The copper-ore lode at Hardstaff's—an ore-channel from 18 inches to 21 inches wide—is in the granite on the side of a hill, which is one of the slopes at the base of Mt. Duncan, a peak of the Dial Range.

None of the intrusive rocks exposed on the sea-coast between Ulverstone and Penguin belong to this division. Where they are granitoid they are connected with the porphyroid group, and not with the Devonian granite.

(*d*)—*Basalt.*

The Tertiary olivine basalt caps nearly the entire tableland south of the sea-coast for miles inland. The ordinary type has, under the microscope, hypocrystalline and doleritic structure. Occasionally the felspathic component disappears, and the micro-structure and mineral constitution indicate a limburgitic facies. This is noticeable in the basalt in the Forth Valley.

AMPHIBOLITE.

South of Bourke's land, about a mile from Hamilton-on-Forth, on the Wilmot-road, a hill range of amphibolitic schist skirts the road. Judging from the exposure of quartzite schist in the hillside at the back of Bourke's, the amphibolite would lie between that and the serpentine. An outcrop of it also occurs in the garden in front of the cottage. Apparently it belongs to the Pre-Cambrian series.

The rock is a zoisite-bearing garnet amphibolite, and may be placed in Grubenmann's order of meso-amphibolites. The three families composing this order [garnet amphibolite, plagioclase amphibolite and zoisite—(and scapolite)—amphibolite] are often geologically associated with one another, and passage-rocks are known. In the present instance we have a variety which unites the garnet and zoisite amphibolites.

The variety probably represents the metamorphism of a basic rock, the original pyroxene having contributed to the formation of amphibole, olivine and plagioclase being represented by garnet and zoisite. Grubenmann derives the garnet amphibolites from eclogites, and points out that the garnet of many eclogites changes in the middle zone into a mixture of hornblende and felspar (or of biotite and felspar), and subsequently into zoisite and epidote.

No felspar is present in this rock. The component minerals are hornblende, garnet, and zoisite, with granular quartz. The hornblende is pale green, the zoisite colourless to grey, giving fusiform sections with prisms parallel with the hornblende crystals and with each other. The garnet is in anhedral rounded crystals, pale pink by reflected light, colourless or pink-tinged in thin section. The structure of the rock shows the schistosity of recrystallisation.

Another amphibolite, coarser and non-schistose, occurs on the crest of the hills above and west of the Alma Mine. This was possibly originally a gabbro. It consists of large plates of hornblende pale green in thin section, crystals of colourless augite and cloudy felspar, in which lamellar twinning lines are well nigh obliterated. This rock seems to fall in the family of plagioclase amphibolites. Its geological occurrence cannot be properly known until more is known of its immediate surroundings. It does not occur in the crystalline schist area, but in the slate-breccia Cambro-Ordovician zone, and in the neighbourhood of porphyroid exposures.

V.—MINING PROPERTIES.

(A)—Copper Creek Mine.

This mine is situate on the Copper Creek (or, as it is named on the charts, Walloa Creek), about 1¼ mile from its confluence with the Leven River, at Mr. Wells' farm, Gunn's Plains. The section, 40-acres, No. 252-M, is charted in the name of Mr. W. R. Applebee. Besides this, three adjoining prospecting areas, of 80 acres each, have been taken up by the mine-owners, who have now registered their syndicate as the Copper Creek Mining Company, No Liability.

In the old days outcrops of copper ore were discovered on the banks of this creek by the late Mr. James Smith, and it is believed that he worked somewhere in the vicinity of the present mine.

An outcrop in the steep creek bank was discovered about seven years ago, and Mr. W. R. Applebee took up 40 acres for mining purposes. In 1903 a departmental examination of the creek was made, and a copper ore lode-formation with a calcite gangue was inspected a little below the present mine. Samples chipped from the outcrop were assayed in the Government laboratories, and returned 4·8 per cent. copper and 2 ozs. of silver per ton. Other samples taken to Launceston by Mr. Percy Harrison were assayed at the Mt. Bischoff Smelting Works and yielded 2·3 per cent. copper and 9 ozs. 16 dwts. silver per ton. The bands of copper-bearing calcareous slate were recognised as being in a favourable position for prospecting drives, and it was considered likely that further exploration would disclose something more payable.

Another lode was found to crop out on the hillside about 250 feet above the creek, and the present company has devoted its attention to this.

The work which has been taken in hand by the company in connection with this lode comprises the following:—

(1) Trenching on the gossan outcrop near the hut 300 feet above the creek.

(2) An open-cut into the lode outcrop on the hillside.

(3) An adit driven 60 feet into the hill, intersecting the lode at 39 feet in. This is 30 feet below the open-cut.

(4) A lower adit driven at creek-level for 28 feet, intersecting the lode in 200 feet of driving.

The above will now be described *seriatim*.

(1)—*Gossan Trench.*

A small cut has been put in at 40 feet south of the hut for 12 feet in a north-westerly direction on the course of a line of gossan which looks fairly promising. About a foot of gossanous material is showing in the trench, but the full width has not been ascertained. The company sent some of it to the Government Analyst, with a result of 0·75 per cent. copper and 1 dwt. gold per ton. My samples, assayed in the Government laboratories, yielded 17 grains gold and 18 grains silver per ton.

(2)—*Open-cut.*

An open-cut has been driven into the hill for 17 feet in a south-easterly direction, exposing the lode 3½ to 4 feet in width, vertical, widening underfoot, and striking about 15° east of south. The lode gangue is slate, calcite, and quartz, and contains bunches of specular iron ore, pyrite, and a little copper sulphide. The country rock is a light-coloured slate, which becomes harder as it approaches the lode.

(3)—*Upper Adit.*

Thirty feet below the open-cut an adit has been driven for 62 feet in a direction S. 65° W., cutting the lode at 29 feet. The bearing of the lode being here S.E., the adit has intersected it obliquely, and, in consequence, the width of lode passed through in driving is greater than its actual width. The apparent width is between 6 and 7 feet, but the true width is about 5 feet. The lode-matter consists of a siliceous slate gangue of greenish hue, and distinctly brecciated, well mineralised with pyrite, chalcopyrite, covellite, and specular iron ore. It is widening also in this adit underfoot, and the stone is of better quality than in the open-cut above.

My samples from this lode returned, in the Government laboratories, 2·9 per cent. copper and 2 dwts. 8 ozs. silver per ton. I am informed that the ore broken and sent away was of higher grade, and that the owners anticipate that it will be possible by selection to produce ore of marketable quality. It has been driven upon for a few feet south. Two and a half tons of ore from this point have been forwarded to the Mt. Lyell Company's smelters at Queenstown, but the quantity was too small for treatment by itself, and the ore sent has remained unsmelted.

Both the lode and strata underlie to the N.E., but a few feet behind the end of the adit a pug seam occurs, beyond which the slate dips S.W. into the hill. The underlay of the lode will cause it to be met with in crosscuts lower down at increasingly shorter distances.

(4)—*Lower Adit.*

A bottom adit has been put in to intersect the lode at the level of the creek. No surveys have been made of the surface features, and from the precipitous nature of the ground, it is not easy at a glance to see what positions the mine openings occupy in relation to one another. The bottom level, however, appears to be 150 feet or 200 feet below the upper adit. It has first been driven from the creek in a south-easterly direction across regularly cleaved slates, which have here a strike of N. 70° E. It would appear, therefore, that the strike of the strata differs considerably from that in the upper adit, and it could not be expected to intersect it by driving across these. After driving 90 feet into the hill, the direction of the crosscut was changed to south-westerly, and at 100 feet thereafter a lode-formation, 9 feet wide, with wet flucans on each side, and carrying about 3 feet of hard, ore-bearing stone, was crossed. It carries a sprinkling of iron and copper pyrites, and its gangue is calcite and slate, the latter inclined to be black and greasy. From its position and character it would seem to be the same lode as the one cut above, but absolute certainty on this point is not possible until a survey has been made.

The broken and steep country prevents a simultaneous view of the various outcrops and tunnel openings, and a comprehensive surface and underground survey would be extremely useful in giving data for reliable determinations of positions. The lower crosscut has been driven 80 feet beyond the intersection of the lode. At about 20 feet behind the end is a pug, slate, and quartz-formation, carrying no mineral, but yet indicative of some lode action. This might very well be tested to see whether it leads to anything. After passing through the main lode the country rock changes; it becomes harder and rougher, and a little behind the present end it merges into a breccia. The lode cut in this adit, though not so rich in copper as in the higher level, is not less strong as a formation. It has been strong enough to break through the strata in descending, notwithstanding their change of strike, and it appears to be going down unimpaired. The company states that the lode-matter yielded about 4 per cent. copper by assay. My samples returned 1·6 per cent. copper and 1 dwt. 15 grs. silver per ton.

The lode in the upper level will no doubt be tested first, and the pitch of the ore-shoot ascertained before driving aimlessly at the lower intersection. The company will probably obtain good advice as to whether it would be well to cut the lode a little lower than the present upper tunnel so as to avoid the shallow ground of the gully.

The lode has practically only been cut at the different points mentioned, but sufficient has been disclosed to justify further work, with a view of proving its value.

The section taken up by the company seems to comprise an ore-bearing channel of slate country between two belts of conglomerate or breccia. The lode in the bottom level is situated on a line where the country changes. The end of the drive is unmistakably in a bed of breccia. The face is tolerably dry, though a little water is dropping from the roof a few feet behind the end.

The breccia beds are, perhaps, not quite so favourable for defined ore-channels as the firmer slate country, but there is no reason for characterising them as barren. Some of these breccias are undoubtedly igneous in origin, and carry disseminations of mineral. Ore-bearing breccias are rather common along the flanks of the Dial Range, and are really an encouraging feature of the whole district. No valid objection can be urged against continuing this level into the breccia country.

Other lodes exist on the property, and although their exposures cannot be termed remunerative, taken together they establish the existence of a cuprifrous zone, in which exploration is highly desirable.

McDonald's adit, about 50 feet above the creek, has been driven for 30 feet into the hill across slate strata, striking N. 75° E. At the entrance a small puggy seam of copper ore was met with, and there is said to be another vein in the end, but standing water in the level prevented examination. The company states that some 11 per cent. copper pyrites was obtained here.

Below this adit, on the south side of the creek, is a vein with some copper pyrites and native copper; and still lower down the creek is a further cupriferous channel, from which the company quotes an assay as—copper, 3·6 per cent.; gold, 1 dwt. per ton; silver, 3 oz. 12 dwts. per ton.

Sufficient water-power exists in the creek for all purposes, and the creek route will, in the event of operations proving successful, no doubt be made the outlet to the property. At present a horse and bullock track winds its way up from the plain to the crest of the hill overlooking the mine, at a height of about 600 feet. Before considering the erection of plant, thorough prospecting and underground development must be carried out.

The belt of strata in which the Copper Creek lodes are situate evidently comprises the beds immediately below the Ordovician limestone, which creeps up the hill to within about 15 chains of the north boundary of Kent's block. These beds are consequently Cambro-Ordovician, or, if we regard the limestone as the base of the Ordovician, probably Middle Cambrian. They belong to the same series as the strata cut through by the River Leven in the Sugar-loaf Gorge. The conglomerate which plunges below the limestone on the west side of the creek can be traced right across to the Leven, but the slate belt has evidently been disturbed, most probably by the igneous intrusions of the porphyroid group, which occupy a considerable portion of the hill range between Copper Creek and the Leven.

Wherever in this district we meet with rocks of the group just mentioned, pyrite and a little disseminated chalcopyrite occur, under conditions which indicate the possibility of some ore-deposits being genetically related to this series of eruptives; but further study of occurrences is necessary before any definite conclusion can be arrived at.

About 3 miles north copper-ore lodes exist in the Devonian granite , and the usual reference of minerals in lodes in our stratified rocks exclusively to the granite batholith of that age rests on too broad and firm a basis to be easily shaken. Nevertheless, the constant association of copper ore with occurrences of the porphyroids claims careful consideration.

(B)—RADFORD'S REEF.

On the west side of the Leven Gorge, opposite A. S. Brown's 30 acres, some mining ground has been taken up by Mr. H. J. Colbourn. About 25 feet above the river an open-face has been cut in the hillside, showing slate or shale, passing down into clay strata containing a good deal of manganese oxide at top, and sandstone at bottom, with an intermediate band, about 4 feet thick, of light-grey argillaceous sandstone carrying disseminated iron pyrites and little nests of specular iron ore and copper pyrites, the latter, especially on the faces of small cavities, lined with quartz in crystals. On the north side of the open-cut is a junction of the sedimentary rock with intrusive porphyroid, and this junction can be followed east to the river, where it can be well seen at the point, at which the slate is silicified and brecciated.

The same grey siliceous pyritiferous rock is seen round the point on the river, and a few yards north of it a trench has been cut 10 feet above the water and into the hill in a westerly direction. As far as can be seen the trench is in overburden, which is very deep here, and has fallen in, preventing examination.

The impregnation of the sedimentary strata with a little copper ore near their contact with the plutonic rock is not sufficient to justify further expenditure at this point. South-west of the open-cut the porphyroid reappears on the hillside at no great distance, so that the area of stratified rocks must be extremely limited just here. The whole hill is intersected by numerous intrusions of the igneous rock, and while ore deposits may possibly occur here and there, extreme variability within short distances is likely to be a feature of them.

(C)—BROWN'S BLOW.

This is on the east bank of the Leven opposite Radford's Reef open-cut, and is a wide exposure of flinty slate, carrying a considerable development of quartz. A little specular iron is visible. There is no reef here, but apparently silicification of the slate has taken place near a contact with eruptive rock.

(D)—COLBOURN'S SHOW, ON ROAD.

Beyond the point on the road north of Brennan's an excavation has been made in the solid edge of a large landslip, which has brought down a huge mass of rock bodily. The latter has parted from the standing cliff-face just east of the mine cutting.

The country is a gossanous breccia of the kind described in this report as clasto-porphyroid. The tuffaceous and igneous material contains disseminated pyrite, but the indications do not encourage much expenditure here. Mineral may be scattered through the rock-belt, but there are no signs of lodes or any definite channels in which ore-concentrations occur.

(E)—HEAZLEWOOD'S SILVER MINE.

This comprises some sinking and tunnelling done at an outcrop on the Leven River south of Griffin's 30 acres, 7 miles south-west of Ulvertsone. The discovery was made in 1891 by Messrs. Lines and Elliott. Mr. Lines informs me that some of the galena from it was sent to the Launceston Exhibition in that year, and that the assay went from 15 to 20 per cent. lead and 36 ozs. silver per ton. Definite information, however, is not available now. The show was idle for some time, and then between £300 and £400 were spent upon it; but I understand the country was loose, and there was a difficulty in getting into solid ground. Nothing can be seen now unless some preparatory work is done. A mile above this, I understand, a large gossan formation was found.

(F)—PRESTON SILVER MINE.

Section 249, 80 *acres.*—This is situate in the Castra Parish, 4 miles south-east of Gunn's Plains, and is reached by the road running through from the coast to South Preston and Nietta. The road is metalled nearly to the turn-off to the mine. The tableland over which the main-road passes is capped with basalt and basaltic soil, but leaving the road, on the mine track to the south-east, the older rocks are soon met with. At a height of 1500 to 1700 feet above the sea is a felspathic (arkose) grit and conglomerate, which is probably of Permo-Carboniferous age. Descending from this to the creek where the mine is situated (one of the branches of the Gawler) the more ancient Cambro-Ordovician conglomerate crosses the creek in a direction east of south, where it adjoins metamorphic slate country on the west, dipping to the south-west at a very steep angle. A little gully on the south side of the creek appears to form the line of junction. In the slate on the west side of the contact are some parallel lode-lines, along which a little galena and zinc blende, with pyrite, have been deposited in the cleavage-planes and joints of the country. Some of the slate has been silicified by the lode-solutions, and is porous and mineralised. Veins of calcite are associated with the metalliferous bands. There is nothing very definite at surface from which conclusions may be derived. A small shaft has been sunk to 15 feet on the south side of the creek, and little pockets of pug were found, carrying galena in slugs. Mr. R. Lee first worked here three years ago, and afterwards Anderson and party. An assay is stated to have yielded 16 or 18 per cent. lead and 36 ozs. silver.

Locally some doubt exists as to the direction of the ore-channel, but a trench between the shaft and the creek should clear this. Indications point to the mineral zones running across the stream, parallel with the bearing of the slate. Other lodes are said to cross the creek higher up. A drive into the hill on the course of the main lode would develop the latter, and give facilities for crosscutting west for parallel lodes.

(G)—RUTHERFORD COPPER MINE.

The Stowport district was visited on the present occasion in order to co-ordinate the geological sequence there with that at Gunn's Plains. Enough was seen to correlate the strata and establish their *infra* Ordovician-limestone horizon.

The Rutherford Mine, on the 320 acres purchased block, has now been idle for some time. The financing arrangements appear to have been inadequate, and funds were exhausted before the prospecting work was properly completed. Ore was discovered in 1899 by the Messrs. Rutherford, who prospected the property in various directions. A tunnel was started, and a small gossanous lode cut just inside the entrance. This lode, yielding some fair quality copper ore, was followed down by sinking, and stoped at 16 feet and 32 feet. The total quantity of ore raised has been 100 tons, returning 10 per cent. copper, with negligible gold and silver contents. The bearing of the lode in slate country is north-east, and its dip north-west. Its width varies from 1 foot to 3 feet, but averages from a foot to a foot and a half. A main shaft was sunk 100 feet to enable the lode to be cut in depth. A crosscut east was opened out from the bottom for a length of 75 feet, and one west for 50 feet. At a distance of 30 feet in the east crosscut, a vein was intersected carrying 8 inches of ore, underlying towards the shaft. This was met with in a much shorter distance than was expected, and gave rise to doubts as to whether the lode had really been cut. The continuation of this crosscut, however, and also a crosscut west, showed nothing further, and the probability is that the lode has actually been intersected at a weak point. There is an obvious necessity here for the proprietors to continue the work of exploration to its legitimate finish by driving on the lode where it was cut in the bottom east crosscut. The west crosscut should also be continued to a formation which lies some distance ahead of the end.

The remarkable development of hematite on this property east of the lode, and running parallel with it, and on the direct strike of the large outcrop on the Blythe River, is an indication strongly suggestive of the deposition of copper and iron ores having taken place on parallel lines. Evidently the copper and the iron lodes in this field are closely related to one another. The copper mines which have been opened in this belt of country further north are on the lodes which are parallel with and near the strong iron lode of the Blythe. Coming south these lodes can be traced to the neighbourhood of the boundary of the granite. Both the copper lodes and the iron lodes are probably genetically related to the granitic invasion.

Local opinion is as strong as ever that these massive hematite outcrops cover lodes of pyritic copper ore. No sulphidic mineral, however, has yet been found, either in the hematite or directly below its outcrop. The most that has been observed is the presence of a few specks of chalcopyrite in the altered quartzitic rock, which is the wall-rock of the iron ore outcrop on Clark's land, north of the Blythe. This supports the view that the iron and copper lodes have mutual relations, but is also consonant with the supposition that they are structurally distinct.

Lode on Road at Turn-off to Dicker's.

On the Rutherford property, at the turn-off down to the Blythe Bridge, a strong gossan formation has been ploughed through in forming the road. This has been intersected obliquely for 6 or 7 feet, and appears to be running south-west, as is the case with the other lodes in the district, and to dip south-east. At one point in the road some hard quartzose veinstone was met with in this formation, consisting of quartz and solid arsenical iron pyrites. Only a few pieces of this solid stone have been turned up with the pick, but there is evidently a metalliferous lode here, upon which it might be worth while spending a little money to open it out and see what it contains. The absence of copper stains or secondary copper ores in the outcrop is an unfavourable indication. The samples which I took yielded 4 dwts. 21 grs. silver per ton, and a trace of gold.

The Blythe iron lode is supposed to pass here, and some loose blocks of porous limonite and hematite are seen on the hill south of the road. I am inclined to think, however, that the true course of that lode is further west, between here and the Rutherford Mine.

The lode on the road is in quartzite country, east of which lies conglomerate and slate, succeeded further east by the limestone on Addison's land. The changes in the strata are visible, but the actual contacts are not seen. This conglomerate, as already mentioned, continues north to the east of the Blythe River iron ore outcrop and to O. Allen's 100 acres; and still further north, behind Mr. Edwards' farm, it is likely that the siliceous conglomerate with white quartz pebbles and jasperoid stones exposed there in the bank descending to a creek is the northern continuation of the same belt. At the latter place it is plentifully sprinkled with pyrite, and copper pyrites is alleged to have been found in it.

From the observations made on this journey the fact emerges, established for the first time, that this set of slate, quartzite, and conglomerate strata, comprising the country between the Blythe and Forth Rivers, forms an infra-limestone geological group characteristically harbouring the copper ores of the coastal districts.

(H)—L. J. CLARK'S LODE.

Across the creek, below Mr. Clarke's house, at Stowport, a short and narrow adit has been driven west into the hill by Mr. Clark in a wide lode-formation, about 10 or 12 feet wide of lode-material, as far as can be seen. A little difficulty has been experienced in finding the directions taken by the lode, but eventually it was ascertained to be southerly. The formation is soft and oxidised, indicative of sulphides below. Black graphitic slate forms the footwall on the west. A little copper pyrites is visible in the stone, which, moreover, is coloured with copper carbonate and sulphate. A vein of hard pyrite was cut inside.

Owing to the configuration of the hill, there is hardly any use in continuing the adit, as no backs are obtainable, and no solid country would be met with. If any work is to be done here it must be by sinking. Probably some water will be encountered from the little creek close to the mine.

The position of the lode appears to be to the west of the western formation on the Rutherford property. The proximity of the granite is no doubt responsible for the series of lodes in this neighbourhood, and a little prospecting work on most of them is quite legitimate.

The present lode, from its width at surface, and its indications of copper ore, warrants some trial work being done on it, and a shaft should be put down to prove the sulphide, which, there is reason to believe, must exist in depth.

(I)—ALMA MINE.

The Alma Prospecting Syndicate has been carrying on mining operations at the Alma, or old Barrington, Copper Mine, as it used to be called. This is situated about a couple of miles above the bridge over the Wilmot, and lies west of the Forth River, above its confluence with the Wilmot River, 10 miles from the sea-coast.

The approach to the mine is by means of the high road from Hamilton-on-Forth as far as the bridge, and then a turn-off through the forest. This road ascends the valley of the Forth River, which has carved its channel down through the basaltic sheet of the tableland into the ancient rocks below. Immediately south and west of the bridge at Hamilton-on-Forth a white saccharoidal Pre-Cambrian quartzite is exposed in craggy cliffs. At about ¾-mile from the township this emerges on the road against a cliff of basalt, on the west of which is a low boss of serpentine, not more than a chain wide. The bank at the back of Bourke's (formerly Field's cottage) shows an exposure of sericitic quartzite schist, striking 340° and dipping S.W. This belongs to the Pre-Cambrian schist series, members of which crop out on the sea-beach east and west of Ulverstone. Further south, along the road, this schist is succeeded to the west by schistose garnetiferous amphibolite. On Baulch's land the amphibolitic belt is succeeded to the west by mica schist, striking 335°, and still dipping N.W.; and further south, on Mr. Wood's farm, the strata are still micaceous and quartzitic schists, with the same trend. Graphitic and quartzitic schists continue until penetrated at Paloona by an intrusion of reddish brown hornblendic porphyry, belonging to the porphyroid group, and identical with the outcrop near Wells' farm, Gunn's Plains.

South of the waterworks building, just over the Wilmot Bridge, at the junction of the two rivers, a dark granular massive rock occurs, somewhat resembling an ancient metamorphic grit; but microscopic examination shows it to be a clastoporphyroid, a tuff of the Cambro-Ordovician series. Angular fragments of quartz and triclinic felspar, with chloritic residues of ferro-magnesian minerals, and with very little base, make up the rock. It is similar to some clastoporphyroids in the Leven Gorge and the North Dundas district.

The mine was originally registered February 15, 1881, and had about £1000 or £1200 expended upon it in those days. The output appears to have been very little, but a parcel of copper pyrites was sent away at one time, the results of which are not known to me.

Literature of the Mine.

The mine was reported upon by Mr. G. Thureau, Government Geologist, in December, 1881 (Report on the North-Western Mineral Deposits, House of Assembly Paper No. 43, 1882). This report stated:—

"Certain portions of the schists in the tunnel exhibit occasionally native copper in the joints. Heavy spar (barite) occurs in conjunction with copper pyrites (chalcopyrite) in small veins enclosed also by these schists, and some of the beds of rocks are slightly stained by green carbonate of copper.

" The workings made by the prospecting proprietary include the usual descriptions of cuttings from the surface on the course of the deposits, and a main tunnel driven in a north-westerly direction to a length of 281 feet. Two crosscuts extend from this tunnel to the west for a length of 33 feet and 32 feet respectively. . . . Throughout the whole length of this tunnel, and of the greater portion of the two crosscuts, black, hard, short-jointed schists prevail, in which the veins of barite occur, which carry a small percentage of copper pyrites. Similar veins are likewise found in similar rock about 6 chains above the mouth of the tunnel. At both ends of the crosscuts a new formation has been discovered—grey, hard, metamorphic sandstones, in which small rounded pebbles may yet be distinguished with some difficulty. . . . . Taking into consideration all the facts and features connected with the cupriferous deposits so distinctly indicated at the surface and underground, and comparing same with mines producing ores in quantity, attention should be drawn to the fact that regular walls are here altogether absent, and that the only reassuring feature on the ground consists in the recurrence of outcrops of gossan in quartzose veins, also containing barite (heavy spar) and carbonate of iron (siderite). These minerals are frequently found in connection with metalliferous deposits, and therefore I would suggest that the tunnel be extended a further distance of 200 feet, more or less, in the direction of and under the largest surface outcrop of ochreous gossan. It would be also judicious to crosscut further west from the tunnel in order to test the contact of the porphyries there with those of the metamorphic schists."

In July, 1905, the present writer reported on a visit to the mine (Report on North-West Coast Mineral Deposits, 26th July, 1905), from which the following is extracted:—

" Three crosscuts have been driven from the tunnel in a south-westerly direction. These crosscuts have touched a parallel belt of hard pebbly sandstone or breccia, which is also seen outside the tunnel entrance to the west. The first one intersected a flat vein 1 foot to 1½ foot wide, carrying a little copper pyrites associated with barytes and siderite, as well as vughy quartz. This was followed for some distance by a drive parallel with the tunnel. A crosscut 50 feet ahead of the end of this drive failed to pick up anything; and a crosscut was driven from the tunnel north-easterly to see whether the mineral continued in that direction. Nothing, however, was met with beyond a little barytes and specks of pyrite. I am told that 9 cwt. of copper pyritic ore were obtained. . . . The occurrence of mineral here cannot be well understood without a knowledge of the geology of the country west of the breccia formation, as the latter may possibly be a shattered contact zone bordering an intrusion of some eruptive rock. . . . . . . Some sort of lode action has evidently taken place at this mine and produced the lode minerals, barytes, siderite, and copper pyrites. The latter may be seen scattered in the breccia, but so far all the prospecting has not revealed anything in the shape of a solid lode. The prevalence of pyrite in the country rock may account to some extent for the abundant gossan. . . . As said above, there is an unknown factor which may yet lead to some discovery in the breccia belt."

Description of the Mine.

About 400 feet west of a small creek running north on the property, and at about 150 feet up the hillside, a small shaft has been sunk to a depth of 35 feet in a strong body of gossan. This gossan line continues at surface from the shaft down the hill to the creek in a S.E. course, and is parallel with the general strike of the strata. The shaft was first started 16 or 17 years ago, when the gossan appears to have been lost; but it has been since recovered, and a drive extended for 22 feet from the bottom of the shaft in a direction S. 26° W., cut across the gossan for 18 feet, and passed into light-coloured pyritiferous wall-rock. The gossan underlies S.W., at between 60° and 70°.

The old main adit was driven into the hill from the creek at a point about 400 feet east of the shaft in a direction a little south of west, and three crosscuts were driven out south, passing through slate and entering pebbly sandstone or breccia. My report of 1905 shows that only a flat vein was followed in a drive from the first of these crosscuts. This vein was from 1 foot to 1½ foot wide, and cut across the slates, carrying a little chalcopyrite in a gangue consisting of loosely combed quartz with barytes and siderite. Lately the adit has been extended further west with the view of reaching the lode supposed to be represented by the gossan in the shaft. At the 327-feet point in the adit its direction was deflected towards south-west, so as to intersect the gossan line below the shaft on its underlay at that depth in the shortest possible distance. According to the plan there is still a distance of 20 feet to drive to reach the lode. At 13 feet behind the present end a lode of barytes 10½ feet wide has been passed through, carrying a little iron and copper pyrites. The adit intersects it obliquely, so that its true width would be about 8 feet. Beyond it the country rock changes from slate to hard conglomerate or breccia, which continues to the end, the lode occurring at the contact. There appear to be several bands of conglomerate and breccia in this hill, and the band which is now in the end of the tunnel must be crossed before the downward continuation of the line of gossan is reached. If, therefore, the idea is to prove the gossan lode in depth, driving must be continued, and when it is reached it should be driven on. A little driving should be also done on the barytes lode when funds are available, with a view of seeing whether its copper contents hold out any prospect of improving.

Barite is a common gangue mineral in spathic copper veins, and being almost insoluble it is not likely that the gossan outcrops seen at surface will pass down into barytic lodes. Gossanous outcrops of such lodes occur only when these are heavily charged with pyrite, and even then indications of the barium mineral are visible at surface. It is probable in the present instance that if some trenching were done on the hillside below the shaft the outcrop of this barytic lode would be found, and would make it absolutely certain that the gossan lode is still ahead of the main end, though if the survey is correct there can be very little doubt of it.

The Devonport tunnel is a short adit about 4 chains south of the main adit driven into the hill from the creek for about 50 or 60 feet in a north-westerly direction. It has been driven across black slate towards the contact of the latter with breccia. The lode-matter, consisting of black slate with barite and disseminated iron and copper pyrites in a puggy channel, has been left on the north side of the entrance.

A good deal of barite exists on the property. About a hundred yards higher up the creek from the Devonport tunnel a broad belt of slate is exposed in the bed of the stream, carrying bunches and veins of barite for an aggregate width of over half a chain. Much of this appears to be crystalline and pure. In other parts it is stained superficially by iron-bearing solutions percolating from the creek banks. A hundred feet up the hill to the east a cut for about 10 feet has been put across a rather solid outcrop of barytes, a little discoloured by iron oxides, but not sufficient to spoil it for exploitation. A sample assayed in the Government laboratories showed the iron contents to be only 0·9 per cent.

Barite is a mineral, the consumption of which has increased greatly in recent years, owing to the expanding requirements of the paint and rubber trades. The best of the crude ore is worth from 16s. to 20s. a ton in America. The ore raised in England has a value of 20s. a ton also, and the selling price of the manufactured article is about £3 10s. per ton in London, ranging from £2 5s. to £5 per ton, according to quantity, quality, and package. As there is a duty of £2 per ton on imports of the latter into the Commonwealth, the trade value in Australia would be about £6 per ton, *i.e.*, for ordinary lots of average commercial quality. Precipitated barium sulphate is chemically pure, and commands much higher prices, being quoted in London at £6 to £7 10s. per ton. No statistics are yet available as to the quantity of barytes consumed in the Commonwealth, but the tonnage cannot be very great. The world's production is not easily obtainable, as the article is frequently included in the statistics under other heads. The production of crude ore in the United Kingdom in 1907 was 42,646 tons, and in the United States 65,579 short tons. Germany exported 111,209 tons of barytes in the same year.

The principal impurities in crude barite are iron oxide and calcite. Where calcite is the main accessory, it can be removed by jigging, but iron oxide is not so amenable to wet treatment. The ore after crushing has to be bleached with sulphuric acid, with more or less success. This process removes all traces of iron. The product is then washed with water, levigated, or "floated"; the floats or lightest particles being the best. The bleached material has then to be dried and mill-crushed to a fine powder.

The porphyroid and breccia on the property show that the rocks are members of the Dial Range metalliferous group. As regards copper ore possibilities, the ore already won demonstrates that some deposition has taken place, and the persistent gossan line, which has been traced for a long distance at surface suggests the desirability of continuing the prospecting work which has been begun.

(J)—LUCAS AND PERRY,S LODES.

About a couple of miles south-west of the Alma Mine are some outcrops of gossan which have lately attracted attention. Two of these have been opened upon by Messrs. Lucas and Perry on Crown land south of W. H. Lucas' 100 acres, 1½ mile west of the Forth River. Its bearing is N.W.-S.E., and the country rock is slate, apparently belonging to the Cambro-Ordovician system. A shaft has been sunk 38 feet, and is still in gossan. A good deal of manganese oxide enters into the composition of the gossan. I am informed that an assay of the lode-stuff made at the Mt. Bischoff smelting works returned 6 dwts. silver per ton.

Two chains to the west is another line of gossan 20 feet wide, and a shaft has been sunk on this also to a depth of 40 feet. The two lodes are identical in character. Samples which I took from the latter one were assayed in the Government laboratories, and contained 2 dwts. silver per ton.

It is difficult to predict what these gossan lodes will eventuate in in depth, as no minerals which can be used as criteria are present in the outcrop. It is desirable to prove them below the unoxidised zone, which, however, will probably extend to a considerable depth.

(K)—CRAWFORD'S LODES.

On Mr. A. M. Crawford's farm, at Alma, about 14 chains west of the road, is a 20-feet seam of mixed gossan and slate, with a small band of pug a few feet wide in the middle. The formation strikes N.W.-S.E., and dips to the S.W. Twenty feet lower down the creek to the west is a formation consisting of country rock veined with calcite and charged with disseminated pyrite.

Opposite Mr. Crawford's gate, on the road, is a long lode-line of limonite gossan, which has been opened upon for 4 or 5 chains at intervals. It has a kindly appearance, but the samples which I took, and which have been assayed in the Government laboratories, yielded only traces of gold. The remarks made above with reference to proving these gossan outcrops apply here too.

VI.—RAILTON.

This district is in the Mersey basin, 7 miles south of Latrobe. To the north of it is the Dulverton coalfield; to the south of it is the Dasher River district, which has yielded gold indications; to the west of it is the high ground of the Badgers, also mineral country; and at Railton itself, east of the railway-line, some land has been taken up for Tasmanite shale.

The country forms roughly the eastern boundary of the Alma and Leven mineral belt, and its potentialities, owing to the general absence of mining works, cannot yet be strictly defined. An examination of its geological features, however, shows that it is part of a zone within which it is perfectly legitimate to seek signs of ore-deposition.

The Ordovician and Cambrian strata are developed here in an instructive manner.

The limestone at Railton yields generally the remains of the genus of extinct cephalopods Actinoceras, as determined by Mr. R. Etheridge, Jun., of the Australian Museum. . It corresponds in geological position with the limestone of the Gordon River, which is also rich in Orthoceratidæ, accompanied by Raphistoma, Orthis, Rhynchonella, Euomphalus, according to Mr. C. Gould (in 1862). The Gordon River limestone has always been considered as equivalent to the Lower Silurian (Ordovician) of Europe. Mr. Gould referred it to the very base of the Lower Silurian of Europe, though he placed the base of the system in Tasmania still lower, so as to include underlying grits and conglomerates, which, according to what can be seen at Railton, appear to be of Cambrian age.

This rock is in the shaft and bore which were put down some years ago, about 100 feet west of the railway-line, near the station at Railton, in a futile attempt to discover coal measures below the Ordovician. The width of the belt is about a mile, for the limestone appears again at the quarry worked by Mr. J. Blenkhorn east of the railway.

Mr. Thomas Stephens, M.A., in 1874, recorded the discovery of beds at Caroline Creek containing casts of trilobites, and in 1882 some of these were determined by Mr. R. Etheridge as Dikelocephalus Tasmanicus (sp. nov.) and Conocephalites ? (now Ptychoparia) Stephensi (sp. nov.). With the tribolite remains were those of small discoidal or planorbicular univalves, which, according to Mr. Etheridge, presented all the appearance of the genus Ophileta. On the strength of the Dikelocephalus, Mr. Etheridge was of opinion that it appears more than probable that the age of the beds is that of the Lingula flags or Menevian beds of Great Britain and the Potsdam sandstone of North America. To show the significance of this reference, the following correlation of the Cambrian groups in Great Britain and North America is inserted here:—

	GREAT BRITAIN.	NORTH AMERICA.	TASMANIA.
ORDOVICIAN, LOWER	Arenig group of Wales	Calciferous group of New York	Limestone at Gordon River, Denison River, Florentine Valley, Junee, New River, Blythe, Gunn's Plains, Beaconsfield, Mole Creek, Chudleigh, Don, Railton
UPPER CAMBRIAN (Olenus and Dikelocephalus fauna)	Lingula flags of Wales	Potsdam sandstone	Caroline Creek Beds, Railton; Florentine Valley and Humboldt Divide with Dikelocephalus
MIDDLE CAMBRIAN (Paradoxides fauna)	Menevian group of Wales	Acadian	? Cherty breccia and conglomerate with slate at Gunn's Plains. Dial Range, North Dundas White pebbly sandstone and conglomerate at Railton and Denison Range
LOWER CAMBRIAN (Olenellus fauna)	Harlech and Llanberis group of Wales	Georgian	

In 1902, Mr. Stephens discovered stone at the head of the Florentine Valley containing another form of Dikelocephalus, which Mr. Etheridge named *D. florentinensis.* The occurrence of the Ordovician limestone at Mr. Blenkhorn's quarry at Railton shows that this rock rests upon the Dikelocephalus sandstone. The exposure of the latter on the track from the quarry is not sufficient to enable it to be seen whether the Ordovician and Cambrian are conformable. Both have a steep dip to the S.W., and strike N.W. A thin band of laminated cellular clay stone intervenes between the limestone and sandstone. The sandstone further east passes into yellow and purplish clay slates, alternating with purple or chocolate-coloured sandstones. An exposure of these occurs on the railway-line near the bridge over the Caroline Creek, about 4 miles nearer Latrobe. Near here the sandstones are also trilobite-bearing. We have consequently a development of the Cambrian for at least 4 miles in a north-westerly direction roughly parallel with the railway-line. About three-quarters of a mile west of the line at Railton near the Methodist church yellowish sandstones and grits are exposed, from which Mr. Blenkhorn obtained a cast of what Mr. Etheridge considered to be raphistoma, a univalve with a geological range from Cambrian to Silurian. These beds, sometimes vertical, appear to have a general steep dip to the N.E. About half a mile S.E. of the quarry hard pinkish, white, pebbly quartzites, weathering into a fine-grained conglomerate, compose a hill near the rifle-range. The rock resembles similar strata, which form Mt. Wright and the east front of the Denison Range, in the Valley of Rasselas, and occupy a similar position with regard to the limestone there. These quartzites would appear to be geologically lower in the Cambrian than the Dikelocephalus sandstones.

(A)—Tune's Reef.

About a mile south of the railway-station, at the summit of a hill, some mining work has been carried on at intervals during the last 18 or 20 years in the way of prospecting quartz veins alleged to be gold-bearing. Trenches and shafts occur at several spots, one of the latter 70 or 80 feet deep; but beyond colours, nothing seems to have been obtained. The country is a coarse yellow and white friable sandstone, belonging, apparently, to the Cambrian system, and is intersected by frequent veins of white quartz. There is no geological reason why some of these veins should not be gold-bearing. A shaft has been sunk at the summit of the hill to a depth of 25 feet, and at the bottom a drive has been put in 20 feet to a lode, and 10 feet further, to the end, in a direction N. 20° E. The bearing of the lode is north of east and south of west, and its dip towards the north. The lode or lode-channel consists of sandstone veined with bands or lumps of white unmineralised quartz of a vitreous appearance. Sometimes the stone is dense and compact, and again loose and vughy. The stone continues in veins and patches from where it was first struck, right through to the end. I have not been able to detect any gold in it.

Railton Resources.

In some of these veins at Railton I believe gold will eventually be found. There has been very little prospecting, and no reliable information can be said to exist as to the reef occurences which are met with at various points. The possibilities of copper ore-deposits in the neighbourhood should not be overlooked. At present the principal mineral product is lime. Mr. Blenkhorn is manufacturing this, and crushing it fine, so as to encourage agriculturists to use it with their seed. Bricks, too, are being made at his kilns.

VII.—CONCLUSION.

The present investigation has resulted in an important advance being made in our knowledge of Tasmanian geology. It has laid the foundation for a more correct appreciation of the geological age of the ore-bearing strata on the North-West Coast. It has tended to disclose the very important part which the igneous porphyroids play in connection with the distribution of several hitherto ill-understood ore-occurrences on the Coast. Incidentally, it has thrown some light on the age of the North Dundas slate series by enabling a correlation to be made. Further information has been gained in respect of the stratigraphical relations of the Early Palæozoic systems with the Pre-Cambrian platform, as well as collateral confirmation of observations made last year in the Gordon and Florentine valleys.

The study of the mineral indications presented in these pages will, it is hoped, be of service to those interested in mining. It will be seen that the deposition of copper ore has been very general all along the Coast, but in no instance has work on the lodes been pushed to a conclusion. Either work has been suspended before cutting the lode, or the lode, when cut, has not been driven upon, or when the ore-shoot which was first cut has been worked out operations have been suspended. The value of the Coast as a mining field has consequently not yet been proved. It is difficult, however, to believe that with so many ore-occurrences there are not some which, when proved, will be worth exploitation. There is still a great field open here for prospecting work. Owing to the trivial nature of many of the indications progress will probably be slow, but there is some justification for anticipating eventual discoveries of value.

W. H. TWELVETREES, Government Geologist.

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